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The Truth of Genetics

IN an article on Dr Waddington's admirable text-book on genetics, it was remarked (*Discovery*, Vol. 2, no. 15) that it was surprising, and lamentable, that a popular account of the subject did not exist. A popular account* has now been published, and it is everything one hoped for.

For two reasons, genetics is easy to explain to the non-scientific public. First, the scientific ideas behind it are simple, sharp and concrete; the theory of Mendelian inheritance is one of the neatest and clearest-edged of all scientific theories; any intelligent person can be shown how lucid were the thoughts of the Abbé Mendel in his monastery garden.

But, though the intelligent person can be shown how lucid these thoughts were, he never has been. The whole theory is so strictly simple that scientists have taken it for granted and imagined that everyone must breathe it in through the air: while, in fact, the general public's notion of heredity, even the intelligent general public's, has not advanced a foot since the seventeenth century, and not much more since the recognition of paternity itself.

It is one of the oddest cases of a whole culture lagging behind a completely accepted, unshakably established, corpus of scientific knowledge. The intelligent public in 1939 is further behind the scientific front in genetics (which intimately concerns the public itself) than in any other branch of knowledge. No scientist has

* *You and Heredity*, Amram Scheinfeld. Chatto and Windus, 12*s.* 6*d.*

taken the trouble to tell them what they would leap to understand; no one seems to have made the slight effort of imagination required to see that people would revel in an idea so positive that they could get their teeth into it, so close to the facts of life that they could test it in their own families. (Incidentally, it seems curious that some sketch of the theory of human heredity did not arise in a polygamous society; and it is something of a reproach to the scientists of Islam that it did not.)

So scientists missed the opportunity of explaining genetics. The author of *You and Heredity* had the advantage of not being a scientist at all. He is (or so it appears from his introduction) a New York journalist: he is certainly, from his book, intelligent, conscientious, full of interest. More or less by accident he came across the established scientific theory of genetics; he was tremendously excited by it himself, and he set about putting that excitement across. It was all fresh and first-hand; he was brimming with intellectual vigour, but he did not mind an idea being elementary, he was ready to hammer home the facts about the inheritance of eye colour, he cheerfully drew pictures of eyes and the combinations of genes which are responsible for each colour.

The general theory, as I have said, is very simple. Mr Scheinfeld makes sure that anyone can understand it; his very enthusiasm helps to drive the theory home, and the way he shows it to apply is lively and picturesque. Not that there is anything slipshod about his treatment: once or twice he over-simplifies, but Professor Haldane and Dr Waddington both judge the book to be sound in essence; he has taken the best authorities, and, though his taste is sometimes a little hysterical, his intellectual thoroughness and integrity are not affected. Many more "gentlemanly" writers would be the better for his fundamental desire to write down the truth.

The result of it all is that he has produced an account of heredity, which is popular, true, and which makes the scientific laws absolutely clear. By and large, it could hardly have been better done.

And there is the second reason why it should be done. Everyone both wants and ought to know these facts of genetics, because they affect our views of human life. They are simple: and, so far as human affairs are important, they are vitally important. No rational world can be constructed without them.

If Mr Scheinfeld's book were a standard text-book in all the schools of the world, it would be much more difficult for the bogus genetic rules of thought to survive. By the bogus genetic rules of thought, I mean, first, race theory: which is, of course, a genetic theory which happens to be wrong. But I mean also the theory of aristocracy: which is another genetic theory with no more foundation than the racial one: and which in this country helps implicitly to sanctify the snobbism which is our most characteristic national vice.

Mr Scheinfeld's work would also help to dispel an error which, unlike the other two, has tended to gull liberal-minded men. For, even before Rousseau and ever since, it came naturally to optimistic liberals to think that environment meant far more than heredity: that, given the chance, all things were possible to any man.

Men of realistic insight always knew, of course, that that naïve optimism was utterly untrue to life. Now there is no excuse for anyone not to know that it is proved untrue by the overwhelming corpus of genetical facts. If your parents each had blue eyes, then it is almost certain that you cannot have brown eyes yourself: in the same way, if one of them does not possess 'musical' genes, you yourself are unlikely to have a musical talent. And so it works with mental and emotional make-up, though the intricacies are as great as those of men's minds. Unless you have the genes for high mental activity, no training or environment in the world will make you a clever man: though, of course, a bad environment may cripple you even if you have the genes. But environment can, at the best, only let you fulfil your genetic possibilities, and these possibilities are as innate, and vary as sharply, as the colour of men's eyes or the shape of their skulls.

Some people find this an unpleasant truth. It brings a taste of determinism inexorably nearer home. But it is the truth; and if ever a liberal world is to flower, it will have to be founded on the bleaker truth, and not upon optimistic day-dreams.

THE EDITOR

Minerals in Wartime Foods

There appears to be a definite danger of certain mineral shortages in war-time diet. Readers who found the November article on Vitamins of service, will welcome Dr Watchorn's advice on avoiding the dangers of mineral shortage by simple methods available to everyone.

By Elsie Watchorn

THE problem of the requirements of the animal (and therefore of the human) body tends, like so many other problems, to grow in complexity with increase of knowledge. So often what appears to be a comparatively simple affair is so only because our information concerning it is scanty. Modern methods of spectographic analysis have revealed the presence of no less that fifty-five different mineral elements in the human body. True, many of these are only present in traces, but this does not rule out the possibility that they are important, or even actually essential. Already one or two minerals, formerly believed to be present in the body in small quantities as "impurities", are now known to perform important physiological functions, and this may turn out to be the case with some, at any rate, of the trace elements. These latter may not be so important from the dietetic point of view, for it would appear to be difficult to eat at all without getting a sufficiency, since they are present in almost all plant and animal tissues. Caution is needed on this point, however, for the case of iodine immediately comes to mind. It has been calculated that adults need not more than two-millionths of an ounce daily (less than a quarter of a grain a year), and yet there are districts where the water is so lacking in iodine that all the plants and animals (and hence the people who eat

them) are deficient, with serious results to the functioning of the thyroid gland. Because extremely small quantities of a substance are all that are required it does not necessarily rule out the possibility that a deficiency may occur.

Minerals known to be required in appreciable amounts are calcium, phosphorus, magnesium, sodium, potassium, chlorine and sulphur. These are all known to be essential to life itself. Nevertheless, some of them will generally be adequately supplied by our food, unless indeed we are reduced to the level of a semi-starvation diet. Sodium, potassium and chlorine are easily soluble and offer no difficulties in connexion with digestion, absorption from the gut or utilization by the tissues after absorption. We shall certainly not be short of sodium and chlorine so long as common salt is available, for the majority of us eat our daily requirement many times over in the course of each 24-hour period. Potassium is also ubiquitous and abundant in both plant and animal foodstuffs, and a shortage of magnesium can probably be regarded as unlikely. Sulphur is interesting, for whereas in the case of most minerals the body prefers, or even demands, that they shall be supplied in simple forms, with sulphur the opposite is true. Simple sulphates are not used by the body, the whole requirement has to be taken in the form of organic compounds which are found in meat, dairy products, and to a lesser extent, vegetables.

It is when we consider calcium and phosphorus that difficulties may arise. The importance of these two elements is obvious when we remember that they form the greater proportion of the bony framework of the body. A steady adequate supply must be provided for this purpose not only for growing children, but also for adults, because the bones of the latter, though not growing in size, are nevertheless "alive"—salts are continually being removed and new material laid down. Calcium and phosphorus perform other important functions besides bone-building, and the matter is further complicated by the fact that we do not utilize the full amount that we eat of these two minerals. They may form insoluble salts with each other or with other substances, and consequently may never be absorbed into the blood stream. An adequate supply of vitamin D seems to be essential for their absorption and also for their deposition in bone. Moreover, for the latter purpose calcium is useless without phosphorus; fortunately they are frequently found together in our foodstuffs. Under the best conditions probably not more than 70% of the calcium eaten enters the body at all, for physiologically speaking a substance is not "in the body" until it has been absorbed from the intestine. Allowing for this, the estimated requirement for adults is roughly 1 g. (about 28 grains) a day of both calcium and phosphorus. Children need about the same—that is to say, more in proportion to their weight. During pregnancy the need is also increased. The best sources of calcium are milk, cheese, eggs, green vegetables and nuts, and of phosphorus meat, fish, milk, eggs, cheese, cereals and nuts. Meat (since we do not crunch up the bones!), cereals (and hence bread) and fruit are poor sources of calcium. Phosphorus is thus seen to be more easily got than calcium, and if we pay attention to the requirements of the latter we shall almost certainly get sufficient phosphorus as well. About half the phosphorus of plant foods, however, is in an insoluble form known as phytin, which is not only practically unutilized by the body but which may combine with calcium and render that also unavailable. The daily requirement of calcium and phosphorus is supplied by 1½–2 pints of milk, in which these minerals are present in the right proportions for bone formation and in forms which are easily assimilated from the gut.

Iron is another important mineral. It is a constituent of haemoglobin, the red colouring matter of blood which is essential for the carriage of oxygen to the tissues of the body. In an ordinary well-mixed diet the iron appears to be amply sufficient for

the needs of men, but investigation has shown that the majority of women of all social levels are to some extent iron-deficient, probably because their lower food intake does not permit replacement of that which is lost periodically. Milk, so good for the supply of calcium, is almost completely devoid of iron, and the best sources are eggs, liver and green vegetables. Brown bread is also good, but, contrary to popular opinion, meat is not. There is, indeed, plenty of iron in meat, but as with the phosphorus of phytin, it is unavailable for the need of the body as it is in a complex organic form which is not broken down during digestion. Though the daily requirement of iron is small, unfortunately so is the iron content of most foods. The "daily dose" is contained in about 2½ lb. of brown bread or in about 15 eggs, while if we try to get it in the form of lettuce or cabbage it would be necessary to eat 5 or 6 lb. or even more, since not all the iron in green vegetables is utilized.

Looking over the facts briefly outlined above, what emerges? Is it likely that a shortage of minerals could occur in war diets? I think the answer is undoubtedly "yes". A shortage of calcium and phosphorus can be prevented by an adequate intake of milk. Skimmed milk would serve this purpose and if marketed would form a cheap and admirable supply of most minerals without reducing the country's butter supplies. At present, however, this goes to factories to make such articles as door knobs and fountain-pen barrels. What is needed is an ample supply of milk at a low price and an intensification of the "Drink more Milk" campaign. For in spite of the considerable success of the latter there remain large numbers of children and adults of all classes who do not take full advantage of this valuable commodity. It is to be hoped that local councils will use the new powers acquired by them this year to provide cheap milk for expectant and nursing mothers and children under school age.

An inspection of other good sources of calcium and of the best iron-containing foods show that these tend to be the expensive ones. Eggs, during the last war, became prohibitive and show signs of becoming so again. Already a household of six can only be supplied with a daily egg at a weekly cost of 10*s*. 6*d*. Egg substitutes used for cooking have no food value whatsoever. Brown bread or a "standard" variety might with advantage be introduced, and much might be done by the encouragement of home cultivation to improve the supply of fresh green vegetables, though it is hardly necessary to remind anyone who has had the experience of feeding small children that these are rarely acceptable articles of diet. The child's intense dislike of "greens" is almost universal, and raises the doubt in one's mind as to whether there may not be a fundamental physiological reason for this, as there is for their dislike of fats and their ardent fondness for sweets.

To sum up: There appears to be a definite danger of certain mineral shortages in wartime diets. Some of these could be avoided by ensuring supplies of milk at cheap rates (for instance, skimmed milk, which has the further advantage that it is well tolerated by children who cannot take full-cream milk), by encouraging home cultivation of green vegetables and by substituting brown bread for white. Of course, a shortage in the food of calcium and iron, etc., can be supplemented by taking tablets or pills of suitable composition. These need not be expensive, though they usually are. But these preparations are often not very well utilized by the body and, moreover, food which is deficient in minerals will probably be deficient in other respects, so that it is therefore better to see that the diet contains adequate supplies of minerals in a natural form rather than to rely upon their artificial addition. In particular, the diet of children needs special care in this and other respects if our future citizens are not to be seriously handicapped at the start.

F. FRASER DARLING

WILD LIFE CONSERVATION

Once a year the people of Ness journey in an open boat to a rock in the Outer Hebrides to take approximately 2000 *young gannets for winter food. This, and other deplorable activities against the preservation of wild life generally, is criticized in this article by Dr Fraser Darling whose various contributions on bird life, seals, and Scottish Islands, is well known to readers of* Discovery. *Dr Darling wants a Bureau of Biological Survey, by whom, he suggests, such problems as the diminishing gannet colony, and the protection of grey seals and other wild life could be solved.*

WHEN Moses instructed the Israelites to leave unharmed a bird's nest upon which the mother was sitting, yet allowing them to take the young if the mother was not there, he was making one of the first-known laws for the conservation of wild life. He was also showing how taboo has operated to the benefit of some animals. The particular passage of Deuteronomy (chap. xxii, 6) states two conditions—one when the mother is there, the other when she is not—and only in the latter event may the young be taken. There is a touch of what is called sportsmanship about it, in the same way that a rough shooter does not take his rabbits sitting. Taboo is of great importance to the wild swans of the West Highlands, for no native of the country would shoot one or disturb it from the lochs where these birds come in large numbers in the winter time. Geese, on the other hand, are unlucky in that they are eagerly hunted, and they become more wary in consequence. Taboo tends to die out as civilization becomes more sophisticated, and the modern world must substitute something else, equally potent, for the preservation of its swans. If we sub-

stitute science for superstition and taboo, we shall preserve the geese as well.

Marco Polo, in the evergreen account of his travels, describes the high level of game conservation practised in the realms of the Great Khan. Kublai had advanced far beyond Moses, for he brought about increase of game by imposing a long close season from March to October when the animals were breeding, and he went to the trouble of planting millet along the sides of a valley where quail were abundant. The Great Khan employed gamekeepers who fed quails and partridges in much the same way as the twentieth-century keeper feeds his pheasants on tail corn. Progress beyond this stage of game preservation is extremely slow, and it takes an entire change of point of view to extend active preservation beyond species which can be hunted for sport or food.

Game preservation in Britain has a long history. Canute was setting aside forest areas before the better known work of William the Conqueror carried the reservation of "forests" to an inordinate length. The royal forests were "privileged for the peaceable being and abiding of wild beasts and fowls. . . to be under the king's protection for his princely delight". The nobility followed the royal fashion by establishing "chases". All through, we see that preservation of certain species such as red, fallow and roe deer, pheasants, partridges, quails and bustard, was carried out purely for the amusement of a privileged few. We may have a different social outlook now, but we should be thankful, nevertheless, for those despotic customs and laws of nine hundred years ago. They did ensure the continuance of living space for particular wild animals and, incidentally, for a host of others. The break-up of the feudal system was certainly not to the good of wild life generally. Bounties were given after the Reformation for killing such animals as kites, hawks, buzzards, choughs, shags, cormorants, bullfinches, kingfishers, pole-cats, weasels and wild cats. The idea that the presence of animals such as these was responsible for the shortage of agricultural crops, of fish and game and of fruit, was long persistent and is by no means dead, but as knowledge increases it becomes apparent that most indigenous animals can be given their place in the sun in a well-balanced economy. We can appreciate animals now for their beauty and the interest of their lives, and that is one of the factors making for preservation in the future. The industrial development of the nineteenth and twentieth centuries has taken heavy toll of our wild life, but this should not be forgotten—it is urban

Some animals look after themselves by having protective colouring or disruptive patterning. This picture of two eider ducklings shows clearly the prominent eye-stripe which detracts attention from the eye itself

opinion which is now most anxious to take care of what remains. In how many country places will the moorhens walk round your feet as they do in St James's Park?

The marriage of sentiment to science produced Theodore Roosevelt's dictum of "conservation through wise use". This idea has become the basis of wild-life policy in the United States, but the word has hardly filtered through to British minds and certainly not to the governmental mind, which has no wild-life policy of significant value. Yet the body of knowledge is growing—of ecology, the relation of the organism to its environment; of disease control, and of the natural rise and fall of animal populations which are often virtually independent of the predatory animals referred to as vermin. We certainly need much more knowledge to be sure of adequate conservation in Britain, but the pity of it is that no administrative machinery exists at present to apply the results of research done so far. There is a limit to what individuals and small societies can do in the way of establishing and managing wild-life reserves.

Sula Sgeir, the famous gannetry 37 miles north of the Outer Hebrides, the only British gannetry from which the young birds are taken for human food

America is ahead of us in having a Bureau of Biological Survey and a National Forest Service. These Federal departments are in exactly the right position to apply the idea of conservation through wise use. They are conducting research and experiment themselves in the national parks and forests and have an extensive literary department combing the world's output of biological research which might have a bearing on their own problems of management. Conservation does not mean blind preservation, a sentimental point of view which is often likely to defeat its own ends; conservation acknowledges that many animals can be looked upon as natural resources, and, rather than hinder their utilization, is ready to develop it. The newness of the idea, to our era at least, is that taking toll of natural resources of animal life need not mean exploitation.

Let us take a topical example in the gannets of Sula Sgeir. Sula Sgeir is a rock 37 miles north of the Butt of Lewis in the Outer Hebrides, inhabited in summer by about 4000 pairs of gannets. Since time

A few of the Cyclopean terraces of Sula Sgeir where the population of 4000 *pairs of gannets is rapidly decreasing*

immemorial, the people of Ness, Lewis, have made a journey to Sula Sgeir in an open boat during the early days of September to take young gannets for winter food. Their present toll is about 2000 birds a year, more than the gannetry can stand, with the result that the stock is diminishing. There has been a considerable outcry from the preservationists pure and simple to put a stop to this annual journey. But the final result has only hardened opinion against any interference, and the boat went again this year.

The conservationist's point of view would be to consider man as a predatory animal in this instance and include him in the ecological scheme. The open boat in which the journey is made is of Viking type and the only one of its kind remaining in commission in the Outer Hebrides. In an age when skilled physical effort of this kind tends to be dropped and the ability lost, there can be little doubt that this open-boat journey has a social value in the small community of Ness. If these people did not eat the gannets, what else would they have? The answer is corned beef and margarine, a poor substitute which would bring in the money factor—always undesirable in a semi-primitive community—and allow the boat to rot. What I say in defence of this practice in no way excuses the appearance of roast gannet on the menu provided by the local steamship service!

A group of British workers headed by James Fisher, now Secretary of the British Trust for Ornithology, is making a world census of gannets this year. This is but the most spectacular part of several years' work on the fluctuations of gannet colonies. There is now a good body of knowledge concerning the dynamics of population in this species, but in the heated correspondence and such official enquiry as has been made, no reference seems to have been made to it. If we had a Bureau of Biological Survey in this country the problem would have been referred to it as a matter of course, and it would have treated the gannets as a natural resource. The toll of gannets would neither be prohibited nor

The eider duck on her nest. Another good example of how a bird can hide itself

passively encouraged, but regulated. If 1000 instead of 2000 were taken for the next 5 years, and the fluctuations of numbers studied on this remote islet, the safety of the gannetry would be ensured and the Ness men would continue their 1000-year-old custom.

The Atlantic grey seal is another animal which has suffered in the past from exploitation and is now protected by a law prohibiting any killing during the breeding season from 1 August to 1 December. Agitation in Cornwall and South Wales has made this law a precarious cover for the seals. There is always the possibility of the protection being lifted, and if that happens, the main breeding grounds off the west and north coasts of Scotland would be laid open also. It is not generally realized that protection of any animal that has a food or commercial value is never adequate if protection rests on sentiment alone. Protection based on an understanding of value is much more likely to be effective. These great seals, probably the rarest in the world, were almost exterminated in the nineteenth century by wasteful killing. Crews visited the breeding grounds in November and killed bulls, cows and calves for oil and skins. The disturbance alone must have been disastrous. As the grey seals come to the breeding grounds in late August and early September in an extremely fat condition, ready for a period of several weeks' starvation while breeding, it is obvious that that is the time when any toll should be taken. The bulls come ashore first and the

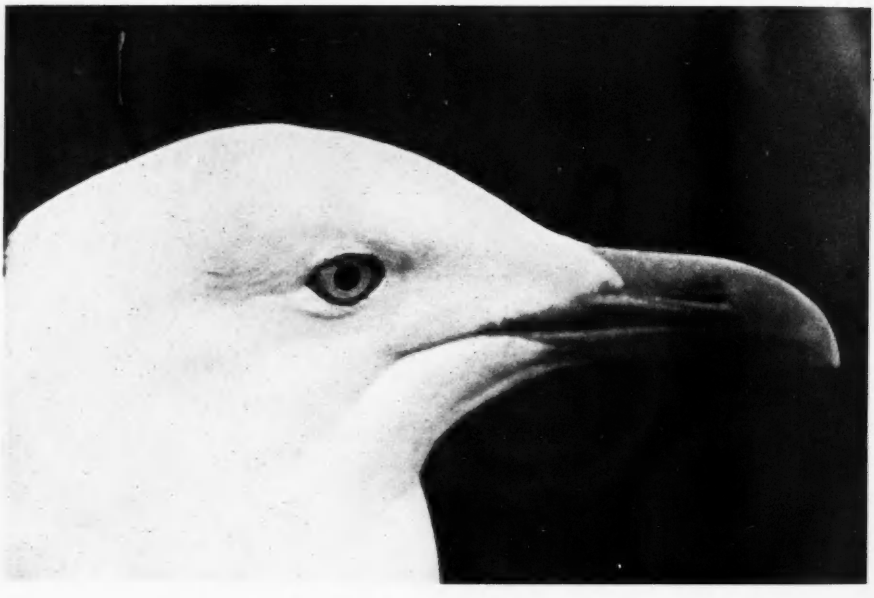
A three weeks old seal calf showing the changing coat

An Atlantic seal cow swimming

stock would be neither depleted nor disturbed by a number being taken at this early stage of the breeding season. I see from my own researches on this species that new colonies could be started on outlying groups of islands, and much of the loss of young stock which takes place at present at the nurseries could be prevented. If the grey seals were treated as a natural resource, they could be more

country's animate resources vested in a Bureau of Biological Survey would ensure the collection and application of scientific data and principles for the good of the animals comprising the natural resources—true conservation.

There remains the large number of animals which, though having no commercial value, are yet threatened by human activities. Each of us can do our



Some birds may be inimical to wild life conservation. The herring gull, if too numerous, can take a heavy toll of eggs of other birds

numerous than they are now and their future protection would be assured. Someone may say that such a seal fishery would never pay. Nor would it, economically; but I visualize a state-controlled seal fishery as part of any well-planned effort to restore the West Highland areas. It would be strictly seasonal and the oil should be used for cattle food in those areas. The meat should also be made into cattle feed and not wasted. Control of all the

little towards protection, but the help of the State in establishing wild life reserves is urgent. Very small reserves may be helpful and in particular circumstances essential, but we need some very large area as well, say a quarter of a million acres in the West Highland region, where land is cheap and where many of the rarer forms of the country's wild life survive. Such a block of land would be a national park open to the public except for restricted

areas, and for this reason alone the reserve would have to be a big place. Enjoyment and appreciation of wild life is a thing which will certainly grow in the public mind, and in a heavily-populated country such as ours there is a limit to the number of visitors which the reserve could accept if the wild life were not to be driven away.

A few large reserves in the more remote parts of Britain would be active centres of research in ecology and wild-life management, work which would link up admirably with that of a Bureau of Biological Survey. The sane view of wild-life conservation considers the species rather than the individual, and that must be the view of a state department. That would in no way conflict with the private opinion of those of us who wished to preserve the life of wild animals as individuals for sentimental reasons.

Lastly, before conservation in this country can become a fact, the law needs considerable amendment in the interests of wild life. Procedure against offenders should be clear and it should be possible to keep a sanctuary as a sanctuary. I have tried, for example, to run an island as a sanctuary for a breeding stock of grey lag geese among other things; but active as I may be on that island, I appear to have no power to stop anyone shooting at birds from the sea, as long as the bird is in flight over the water. The whole subject of conservation is one for organized action, sane planning and constant management.

Dun Cruit and the west coast of Lunga, Treshnish Isles

The Making of Scientific Instruments

By M. C. Marsh

The instrument maker can never run short of ideas, because inventors, industrialists and research workers are continuously bringing their schemes to him. Dr Marsh, of the Cambridge Instrument Company, here tells us of the careful development of ideas into the finished instrument designed to suit industrial needs.

Even those who do not understand their principles are fascinated by scientific instruments, and their fine workmanship makes a great appeal and gives a sense of accuracy which calls forth respect and interest. The more technically minded will look deeper and note how the design incorporates sound mechanical and scientific principles, at the same time minimizing possible inaccuracies. When the inspection of the instrument is complete, there often comes the question, "But who invents all these instruments?"

The answer to this question is that instruments are not the immediate result of an inspiration, but are rather the outcome of a process of careful development. True it is that there is a basic idea behind every one, and this may come from a multitude of sources. There are research instruments created to meet the very specific demand of a research worker. There are special instruments to solve some industrial problem, but by far the greater number are designed to meet some known industrial need. Their purpose is to bring to the industrial user the possibility of accurate scientific measurement with a minimum of trouble and the smallest possible chance of error. They are usually made by mass production or semi-mass production methods, and though they may appear more simple than the special instruments, they often involve more thought, as great consideration has to be given to the best and cheapest methods of manufacture in quantity.

The instrument maker can never run short of ideas about instruments to make. Even if he had none of his own, a supply from outside is brought to him continuously. An industrial man comes along with a proposal that if he could measure or control something in his works, he would save money and turn out a better product. Sometimes the scheme may be impossible either scientifically or economically, but on the other hand such suggestions are often of great value. Then there is the more difficult man, the inventor, who has an idea which he considers to be of great value, and capable of revolutionizing a whole industry. He may have a plan for the measurement of smells, or for controlling the weather! His schemes have to be sorted out carefully, however, as they may contain something really brilliant. The research worker comes to the instrument maker with a definite need, and generally with a definite idea of how to set about the designing of the instrument he wants, though this may only be expressed in a rough sketch on the back of an envelope. It is only people such as instrument makers touching all fields of scientific research who realize how many and how wide these fields are. Besides the researches in pure science and medicine, almost every industry of any size has associated with it a research organization either maintained by individual firms or on a co-operative basis. Added to all these sources of ideas is the instrument maker's own sales staff who by reason of their close contact with many industries are frequently able to put forward valuable suggestions.

It may be interesting to quote a few examples of problems recently encountered, in order to show their wide diversity and extraordinary interest. A research worker

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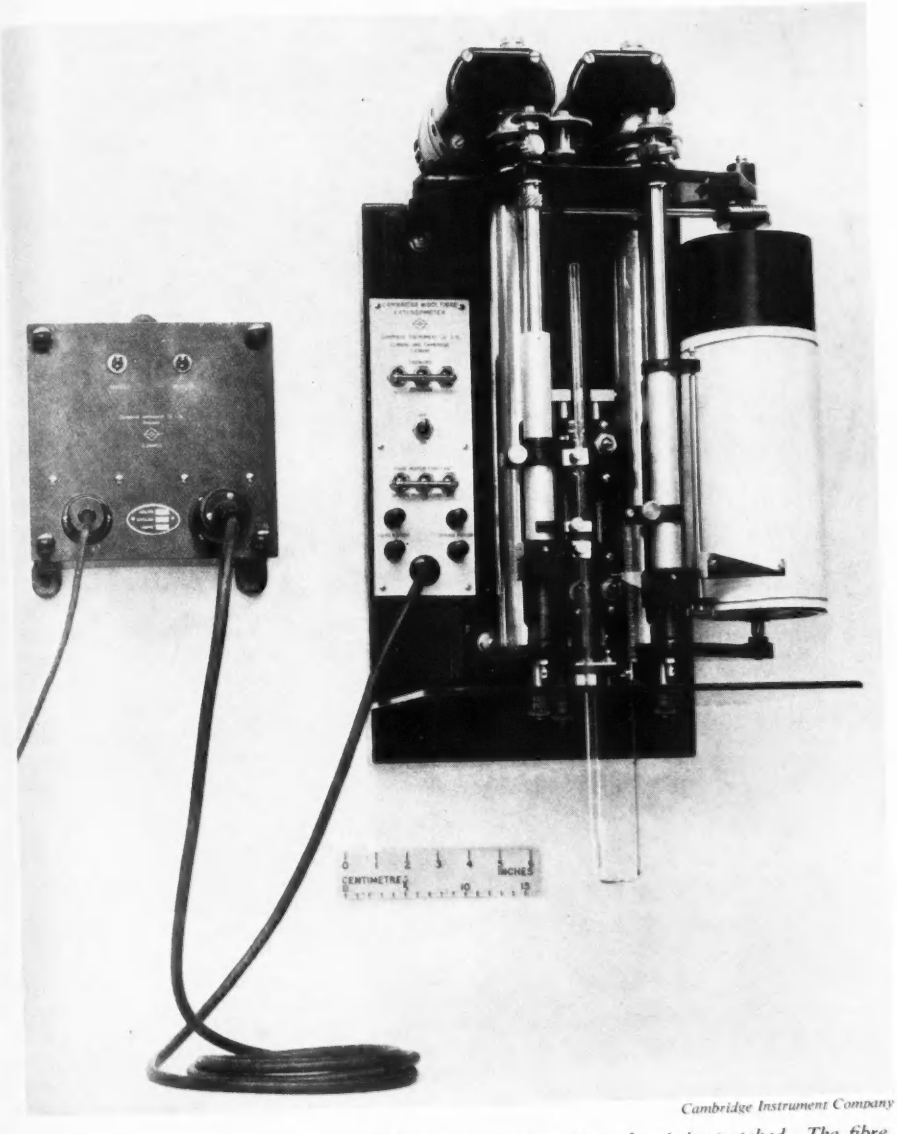

Cambridge Instrument Company

An instrument for recording the tension developed in a wool fibre when it is stretched. The fibre may be under hot corrosive liquids as all the parts in the neighbourhood of the fibre are of glass or are rhodium plated. The unit on the left is a valve relay and mains supply unit

Cambridge Instrument Company

This instrument has been used to measure the tension in colliery ropes by recording continuously the acceleration of the cage, from which the tension is easily calculated. This instrument is one of several instruments in which the record is produced on a celluloid film by a stylus. These records can be read with great accuracy

In this instrument the acceleration or deceleration causes the movement of a mass supported on springs and this moves the stylus across the celluloid film. The zero of the stylus is set by the knob **J** *after unclamping the mass by means of knob* **H**. *The slide* **C** *is then closed and the clockwork which drives the film is wound up by the key* **L**. *The knob* **B** *allows a suitable film speed to be selected but the exact time is deduced from marks on the film produced by an electromagnetic time marker driven by batteries enclosed in the space* **A**.

wishes to measure the tension in a single wool fibre, less than a thousandth of an inch in diameter, while it is being stretched and immersed in hot corrosive liquids. On the other hand, a colliery owner wants to know the tension in the wire rope which hauls up the cage of a coal pit, not only during the steady rise, but also at the first jerk when the cage starts its upward journey. The oil prospector wants electrical, magnetic and mechanical instruments, of great precision and at the same time portable, to enable him to detect the probable locations of oil by small variations of gravitational and magnetic forces, or by measurements on small artificial earthquakes produced by explosions. Then the industrial user demands thermometers for every known situation and purpose, and for every temperature from that of liquid hydrogen to that of liquid steel. There are thermometers consisting of a thermocouple enclosed in a hollow needle for medical use. There are thermometers many feet in length to control the heating of vast buildings. Next a fruit grower asks for some means of measuring the concentration of carbon dioxide in his apple store, to help him to keep his fruit in the best possible condition. Here the experience of similar measurements on the gases in boiler flues is of great help. Another demand comes from the steel industry for means of measuring and recording the thickness of steel strip, not only on the inspection bench, but also as it comes from the rolling mill itself.

All these ideas and suggestions come pouring in on the instrument maker from outside. There are also ideas which come from inside. One instrument suggests another, and often what is apparently a failure in one sphere proves to be a great success when applied elsewhere. Thus a defect in one application becomes the key of success in another. Scientific literature contains many valuable suggestions to the maker of instruments and is constantly searched with this in view. And so ideas come in a never-ending but always tremendously interesting stream. But between

Cambridge Instrument Company

A gravity gradiometer for measuring the gradient of the earth's gravitational field. From the results of surveys with this instrument, it is possible to detect geological formations which are likely to contain oil.

the basic idea and the finished instrument there is a great distance. A long process of development, design, construction and finally testing has to be gone through before the instrument is ready to be despatched from the maker's works.

This point is so frequently overlooked that it is worth stressing with the help of a few examples. A microscope, as illustrated diagrammatically in an elementary text-book on optics, appears to be of quite simple construction, but the actual high-power instrument is far more complicated. Simple lenses are replaced by combinations of two, three, four or sometimes more lenses, the curvature of whose surfaces have all been calculated to correct for the defects of a simple lens. This calculation is often a matter of several weeks of labour, followed by wonderful skill in producing the component lenses with correct values.

Then again, the fact that a pendulum of fixed length has a definite period of swing has long been known. But much work was necessary before modern clocks of extreme accuracy, such as that developed by Shortt, have come into being.

A thermocouple is simple and its effect easily demonstrated, but there are many steps between this and the instrument, which not only indicates but records the temperature at a number of points in, say, a furnace or alternator, and yet the basic idea remains unchanged.

Let us now follow the steps by which a new instrument is developed. If the basic idea is thought to be worthy of consideration, the first stage is for the research or technical staff of the instrument works to look into it carefully to make absolutely sure that it is scientifically sound and practicable, as not a few instruments have come to grief later in their history because of the neglect of this scrutiny. Then they must visualize in a broad way how the instrument is to be built up, how it will work and what the pitfalls are likely to be. Their general experience and their knowledge of analogous problems in other branches of science or industry is often a great help at this stage, especially when this can be combined with the specialized experience of the prospective user, whether he is a research worker or industrialist.

A preliminary design is thus arrived at, but experimental work may be necessary to test the whole scheme or certain parts of it which may be novel. It is sometimes necessary to build up the whole instrument in a rough-and-ready way with available materials before proceeding further, especially if it is to be produced in quantity. An instrument in this form is often very intriguing, and is certainly very different to a finished product. It may cover half a bench although the finished instrument is intended to go into a small case. The main materials may be wood, pieces of wire, plasticine, string, sealing wax, and yet in parts there may be the necessity for some very delicate and skilful work.

Once it has been decided that the scheme is a completely workable one and the general principles have been proved by this early experimental work, the job can move one stage further to the preparation of working drawings and specifications. This is a very important stage, as both the manufacturing and the scientific sides have to be watched and given full consideration. Those who have been responsible for the experimental work are able to give assistance at this stage, but the designer must keep in mind the practicability of making an instrument without undue cost. When quantities are to be made, it is often possible to use mouldings, die castings and metal parts made on capstan lathes.

It is always the endeavour, in designing an instrument, to make its behaviour as independent of precise workmanship as possible. This may sound paradoxical in an industry where such emphasis is laid on good workmanship, but besides reducing the initial cost, this principle ensures that if wear occurs during use, the accuracy of the instrument will not be impaired. To take a very simple example, a part having four feet would only stand on a plane surface if carefully made, and then, if the surface

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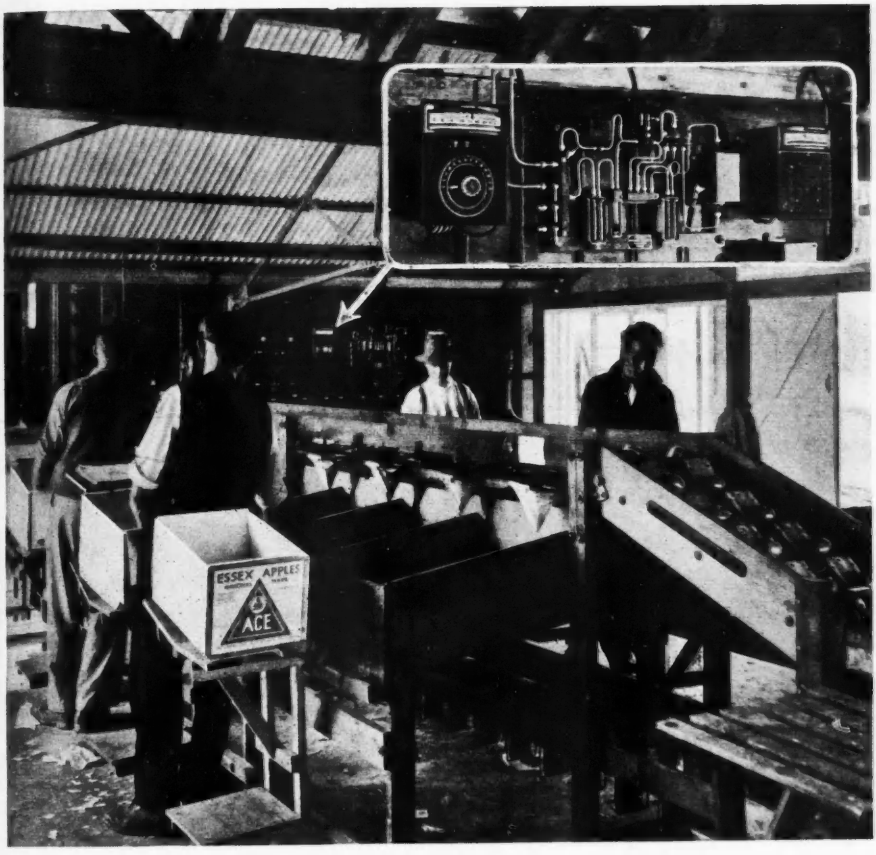


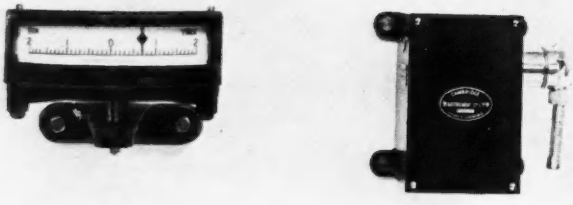
The exterior of an apple store at the fruit farm of Mr G. Y. M. Sketch, Totham, Essex; with the Cambridge Temperature-Indicating Installation for measuring the percentage of carbon dioxide and oxygen shown enlarged in inset

or the feet should wear, a rock would develop; but if only three feet are fitted the part will always stand firmly in spite of wear or the absence of accurate workmanship. This principle can be extended in many ways and forms an important consideration in the design of instruments.

After the drawings are completed, a specification has to be prepared giving a list of all the materials which will be required in the construction of the instrument. The stores of an instrument works appear to contain materials of all types which could be imagined to be necessary, but almost every new instrument brings demands for something which is not available from stock. The search for a suitable source of unusual requirements may be very long and difficult, and if it is found that they are not to be purchased, they have to be made or some substitute used. Materials come from all over the world, and the difficulty

of an instrument maker is long and arduous, and even then it often has to be admitted that a really good man is born and not made. The older-established firms are proud to point out the fact that often the fathers and grandfathers of their present staff have also worked for them, and the skill seems to be handed down from generation to generation.

Instrument work naturally involves a good deal of turning, milling, grinding and polishing, but when compared with other trades which also use these same processes, it includes a large amount of bench work and the use of hand tools. The very nature of the work necessitates that the shops should be well lighted and heated, and in most instrument works almost ideal conditions for the workers are to be found.

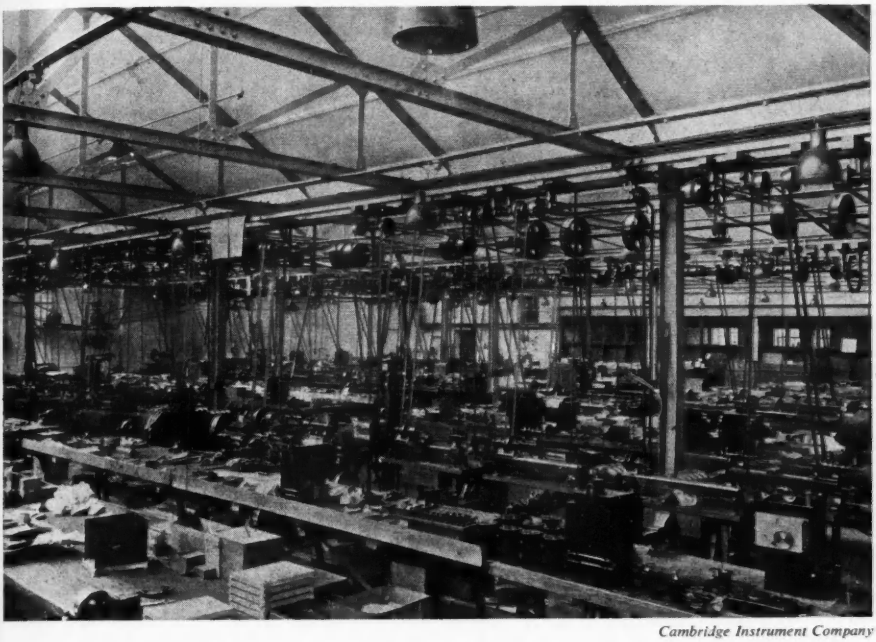


An instrument for measuring the variations in thickness of steel strip. The strip is moving at a speed of 300 feet per minute and yet the readings can be taken to one ten thousandth of an inch with ease

In the larger firms it is possible for certain men to specialize on certain work, such as the mounting of galvanometers, or optical work, or the production of special materials such as glass fibres, aluminized mirrors, etc. These men become very proficient at their particular jobs, and this results in the work being well and quickly done. Apart from this, of obtaining them in time of war is often a cause of concern to the instrument maker, although it may be justly claimed that the position in the present war is infinitely better than it was in 1914.

After all this preliminary work, a beginning may now be made on the instrument. Many people imagine that instrument making is just engineering on a small scale. It is, but to this is added much attention to accuracy and finish. The instrument maker must be a man of skill with a wide diversity of tools and of materials. His patience and care must be infinite, and a good man is not satisfied until his job is perfect in every detail both seen and unseen. The training a special instrument is often the work of one man who may spend months on it. When he has completed the parts of a new instrument, but before the parts are plated or enamelled, it is generally wise to assemble the instrument and to give it a thorough testing. Small modifications may have to be made as the result of these tests, and it is much easier to make these before the finishing processes take place.

In the case where a number of instruments are made up in a batch, they may be the work of a group of instrument makers of various grades of skill. As the number of instruments to the batch increase, so will the number of workers, until in the limit



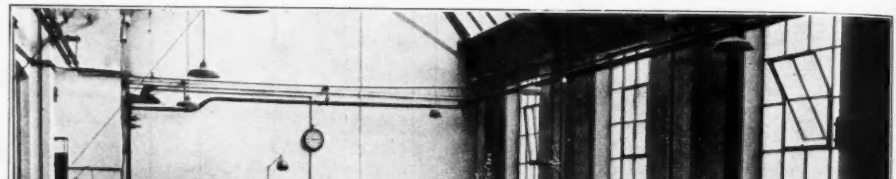
Cambridge Instrument Company

A typical shop in which instruments are assembled. Most of the repetition and heavier machining is done eleswhere but a certain number of lathes are necessary for general purposes

we get mass production where every operation is allotted a worker of appropriate skill. These circumstances are not often reached, however, in the instrument industry. Where instruments are made in quantity they can be assembled and finished right away, as they are always preceded by a sample in which all the difficulties have been encountered and overcome.

It has been stated already that "finish" is a great feature of scientific instruments. There was a time when almost every instrument was finished in glossy black enamel and the brasswork lacquered. The careful work involved in getting a "straight grain" on the brass occupied much time, and tried the patience of young instrument makers to no small degree. The introduction of many methods of electroplating of metals has removed the necessity for the greater part of such tedious labour, although there are still those who say that no finish comes up to that of the old lacquered brass for appearance. By the choice of the correct plating the metal surface can be made resistant to attack from almost any liquid or gas. Thus rhodium plating is being increasingly used in instrument work owing to its highly resistant properties.

There have also been fashions in the enamel finish. A few years back, nearly every instrument maker changed from a smooth glossy finish to a crystalline one. But this was abandoned as it was found that dust could not be easily removed from this type of surface, and the appearance of the instrument deteriorated seriously in consequence. The most usual finish is now a semi-glossy or full-glossy black, although grey is coming into favour, especially for



Cambridge Instrument Company

A testing room where the instruments are calibrated and finally checked before despatch

instruments associated with the communication industries.

Every instrument, after it has been completed in the workshops, has to be adjusted and calibrated and tried out under conditions which as far as possible approximate to those of actual use. In the testing of new or special instruments, the co-operation of those who have done the original experimental work and the designing is of great value, and it can usually be said that when the instrument leaves the works it is about as perfect as human brains can make it.

The despatch of an instrument from the works often calls for much thought, and the packing of delicate apparatus is a matter which demands great experience and skill. It is a common experience to find that the purchaser of an instrument is amazed at the size of the box which arrives compared with the size of the instrument. The extra cost and trouble, however, involved in such careful packing is well worth while as an insurance against the breakage of the valuable contents.

And so the instrument, accompanied by a book of instructions, comes into the hands of its user. With reasonable care, most instruments will give good service for years, often outlasting the equipment to which they are applied. Although modern instruments will stand a great deal of abuse, accuracy and long life are only secured by giving them a little intelligent attention. It is always a source of gratification to a maker to find one of his instruments still in service after many years. In some cases the age is so great that no one remembers the instrument, only its name plate proclaiming its birthplace, and its very existence evidencing the good workmanship put into it.

THE ORIGIN OF THE MOON

By M. DAVIDSON

Sir George Darwin's theory that the moon once formed part of the earth and was separated from it at least 60 million years ago, is, perhaps, generally accepted. In this article, the Rev. Dr M. Davidson, President of the British Astronomical Association in 1936–38 gives a brief outline of the theory, and then points out some objections to it raised by recent research.

LET us suppose that the Earth and the Moon once formed a single body in a molten condition. Rotation would set up a centrifugal force, more especially in equatorial regions, and this would tend to counterbalance gravitation. If we could imagine the Earth rotating about seventeen times as fast as it does at present, centrifugal force at the equator would just balance the force of gravity, and bodies would not remain on the surface of the Earth. There is no necessity to postulate such a rapid rotation to account for the fission of the Moon, because there was another very potent factor in operation—the influence of the solar tide. A very simple illustration will assist in explaining this. If we wish to increase the amplitude of a swing it is only necessary to push it each time it is nearest to us and just turning. By timing the push with the natural period of the swing (this latter depending upon the length of the ropes) it is possible to produce a considerable increase in the arc of oscillation. The name "resonance" has been given to this phenomenon, which has numerous applications in nature, and which was supposed to have been effective in producing fission of the Moon from the Earth.

Imagine a body about the size of the Earth and in a liquid condition receiving a small distortion so that the equator becomes elliptical. Oscillation would take place about the symmetrical form, and it can be shown that this oscillation would occupy about 2 hours. If, at the same time, the rotation period of the Earth were 4 hours, a solar tide would occur every 2 hours, just as we have two tides at present in 24 hours, the time of the Earth's rotation. Remembering the illustration of the swing, it is easy to see that the amplitude of the oscillation would gradually increase, the Earth stretching out towards the Sun. A limit would finally be reached, and the mass would break into two parts, the smaller one ultimately forming the Moon. The question will naturally arise, "Did the Earth and Moon, forming one body, ever rotate in a period of 4 hours?" It is possible to answer this question from the well-known principle of the conservation of angular momentum. Without going into a mathematical analysis we may state this principle as follows: If no forces act on a system apart from the internal, self-compensating reactions, the angular momentum of the system remains unchanged. It is a very simple matter to calculate the present angular momentum of the Earth-Moon system about their centre of inertia, and as this was the same when they formed one body, the time of rotation of this body, which is a factor in the angular momentum, is easily determined. As this comes out about 4 hours, then, from what has been previously said, conditions existed which were favourable for resonance. Assuming for the moment that there was fission, about one-eightieth of the Earth being separated, the portion disrupted would gradually recede and at the same time there would be a slowing down in the rate of rotation of the Earth. Both would occur through the agency of tidal friction

which we need not explain in detail. It will suffice to say that the Moon, as we may now call the disrupted portion, would raise tides on the Earth, and as the Earth was rotating, these tides would cause a certain amount of friction which would retard the axial rotation and so decrease the angular momentum of the Earth. To preserve the angular momentum of the system it would be necessary for the Moon to move away from the Earth, and so in the course of many millions of years it has reached its present position. The slowing down process of the Earth's rotation and also the recession of the Moon are still in progress, though of course they are diminishing as the distance of the Moon from the Earth increases, the tidal effects diminishing as a consequence of this increase.

Darwin was of opinion that resonance took place at least 60 million years ago, though he was well aware that the period might have been very much longer than this. The basic assumption in the theory of Darwin was that the interior of the Earth is viscous, that is, something like the condition of melting pitch, and in these circumstances tidal evolution would have been much more rapid than we now believe possible, since we know that the interior is far from the viscous state. Various lines of research in comparatively recent times agree in confirming this view. Amongst these, reference may be made to the transverse waves in earthquakes, i.e. waves in which the displacement is at right angles to the direction of travel. These cannot be transmitted through a liquid, and since they pass through the interior of the Earth, except through the "central core", it is concluded that the interior is not viscous but behaves like a solid body. As the central core occupies only about one-eighth the volume of the whole Earth, the fact that it is iron in a liquid state under high pressure does not contradict the view that, taken on the whole, the Earth is rigid. Another independent line of evidence for the condition of the Earth's interior is furnished by the well-known experiment of Michelson and Gale described in *Astrophysical Journal*, **39**, 105 (1914), and also in *Journ. Geol.* **27**, 585 (1919). In this experiment the effects of lunar tides were measured in pipes 500 ft. long which were half-filled with water, observations being carried out for nearly two years. If the Earth were a perfect fluid the pipes would rise and fall with the rise and fall of the Earth, and no tidal effects would be noticeable in the water in the pipes. If, on the other hand, the Earth were perfectly rigid, the pipes would remain fixed and the water in them would be subject to tidal influences, the quantitative results of which could be measured. From these experiments it was concluded that the Earth, on the whole, has a rigidity greater than steel. Another important conclusion was derived from the fact that the theoretical and observed tides corresponded in time. If the Earth were viscous there would have been a lag of the Earth tides behind the pipe tides, and as this did not occur, the interior of the Earth cannot be viscous. It follows that tidal friction in a rigid, non-viscous Earth, must have been a much slower process than Darwin thought probable. Of course these results apply for the Earth as it is at present, and the question arises whether in the past the interior was in a very different condition from what we find to-day. Dr H. Jeffreys has shown that the time taken by the Earth in liquefying and solidifying is only a small fraction of its age, so that tidal friction in its interior could never have been an important factor. For this and other reasons, it may be accepted as fairly well established that if ever the Moon separated from the Earth, it must have been four or five times as long ago as the time accepted by Darwin as a minimum. The question now arises whether the Moon ever formed a part of the Earth.

If the Moon was separated from the Earth by the process just described the portion thrown off would not have been in a solid condition. Even if it had been solid,

it would have been rapidly disintegrated by the Earth's gravitational effect. Roche has shown that if we take as our basis a liquid body which is held together by its own gravitation, cohesion being negligible, on approaching within 2·44 times the radius of a larger body of the same density, the smaller liquid body will be disrupted by differential attraction. A well-known example of this is found in the rings of Saturn. In the case of the Earth and Moon the latter could not have existed as a single body until it had receded so that the centres of the two were at least 10,000 miles apart. How did the fragments distributed around the orbit of the Moon unite to form one body? No completely satisfactory answer has been given to this problem. Until a solution is forthcoming it is necessary to treat the tidal theory of the origin of the Moon with a certain amount of reserve.

About eight years ago Dr H. Jeffreys pointed out another serious objection to the theory. In a paper in the *Monthly Notices of the Royal Astronomical Society*, **91**, 169 (1930), he showed that, while theoretically the amount of oscillation in resonance is infinite, in actual conditions there is an upper limit due to internal friction. Reference has already been made to the central core, and it is easy to compute the dissipation of energy from the frictional force of the fluid flowing over the surface of this central core. The rate of supply of energy by the tidal pull of the Sun can also be found, and if the rotation of the Earth ever took place in 4 hours, the friction referred to would dissipate the energy 500 times as fast as the tidal pull of the Sun could supply it. Another calculation shows that the height of the tide attained would be about 0·04 of the radius of the Earth, and with such a small displacement there would be no question of instability and tidal disruption. Both these results eliminate resonance as a possible factor in the production of the Moon.

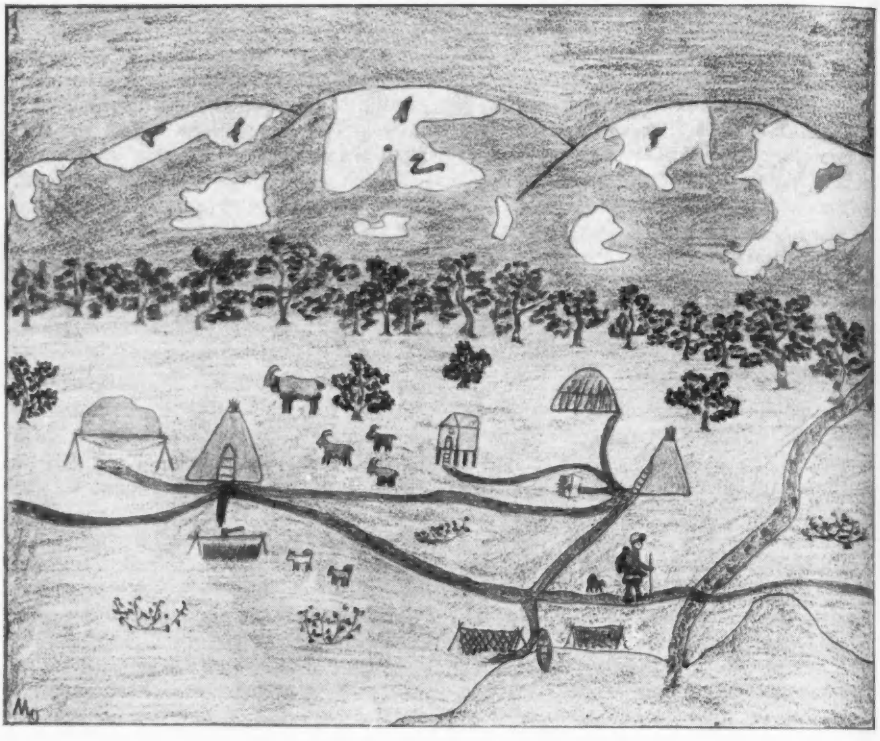
If we abandon the resonance theory of the origin of the Moon we might postulate an origin for our satellite similar to that of the other satellites in the solar system. On the tidal theory of the origin of the solar system it is supposed that many of the satellites were formed by the disruptive action of the tides produced by the Sun as the planets passed nearest to the Sun for the first time. Within recent years Dr Henry Norris Russell has shown that there are grave difficulties in the tidal theory of the origin of the solar system, and other theories have been advanced, but up to the present they have not received general approval. It is possible that the cosmogonist may find it necessary to reconsider the whole subject, not only of the origin of the Moon, but also the wider problem of the origin of the solar system, for which no satisfactory explanation has been afforded.

THINK of the comings and goings of French political life during the lifetime of Pierre Curie. There, if you like, was a prince in exile, living in poverty and neglect and nevertheless working, he and his splendid wife, with the aristocratic devotion of those who own their own minds completely and wait upon the orders of no man. These were magnificent persons.

Or again, Sigmund Freud, a cardinal figure in human thought, who has changed and illuminated men's interpretations of conduct and motive for ever. There, again, is one who made no concessions to person or prejudice in his conception and rendering of the truth. I suppose there is hardly a play or novel written nowadays in which his mighty influence is not to be traced. He has been living in England; he was very anxious to become a British citizen before he died, and he did England a very great honour by that desire.

Unhappily its realization was postponed and frustrated by the ignorance and prejudices of various individuals in the present British Government and now it is too late. H. G. WELLS

Vol. II. Owing to the rapid rise in binding prices it has been necessary to raise the price of binding subscribers' own sets to 5*s.* (*plus* 8*d. for postage*), *instead of* 4*s.* 6*d. as announced last month.*



IN LAPLAND NOW

"Where the sun strikes the fir trees, the bark is brighter; the longest spruce branches point in a southerly direction; and more moss grows on the south side of boulders...." By searching for these clues, the travelling Lapp fixes the points of his compass in bad weather, for there are few roads in Lapland.

In this article, Mr Frank Illingworth tells of his own journey across Lapland by reindeer sleigh and motor bus to Karasuando, more than a hundred miles north of the Arctic Circle, and thence to the tent home of the family of nomad Lapps with whom he lived. The drawing above is the work of a native.

KARASUANDO is seven hours' journey from Kiruna, a mining town 100 miles north of the Circle in Arctic Lapland, and it was bitterly cold as I stepped from the bus and watched two severe-faced Lapps unhitch the trailer which had borne the body of their dead relative northwards. I wondered if the dead man was to be my travelling companion for the rest of the journey, or if he was to be buried among his Mongul brethren here in Karasuando. The wind whipped the stunted herbage, and seared the face, the Arctic day threatened to be short, and, with one ear already frostbitten, I did not look forward to the long journey across frozen tundra by rein-

A herd of

A herd of reindeer on a mountain slope

A reindeer looking for moss under the snow

A Lapp boy with his dog. The Lapp loves his dog who is his guardian against the wolf

deer sleigh. But even as I watched the dead Lapp placed upon a sleigh, Jonas-the-Wolfhunter, with a broad grin on his face, arrived with his reindeer. He was a typical Karasuando Lapp, the most romantic of all Lapps, a wiry little man about 5 ft. 3 in. tall, with slanting eyes, high cheek bones and a broad forehead over which lolled the large crimson pom-pom on his hat; his waist-length tunic with the broad leather belt was snow-flecked, and his trousers were tucked into grass-stuffed boots of reindeer hide.

Jonas was to be my host, and I liked him instantly: his dogs would snap at my heels, his children would stare at me, his wife would cook my food and coffee and we would all sleep together in the same tent and during wakeful moments watch the flaming Northern Lights flash across that patch of sky seen through the large smoke-hole.

I had learned something of Lappish etiquette from my friend Herr Hilding Johannson the Lappfogde (Administrative Official of Lapp territory assigned to the Umea district by the Swedish authorities). You must not, he had said, stride into a Lapp's tent: you may have shelter by all means, so step inside and sit upon one of the logs placed within the entrance; but do not tread over them for fear of offending your host, for they mark the extent of his "hall".

On arriving at the little settlement, Jonas left me while he cared for his reindeer. I entered his tent and sat just within the flap. His wife took no notice of me! Diligently, yet with a baby in her arms, she went from one task to another: shaking out the carefully picked and dried grass used in place of socks, which lay in a heap by the fire; watching the coffee simmer over the flames; tidying the reindeer furs piled in one corner—for all the world like a surburban housewife preparing for a guest—while all the time another baby cried from its cradle hanging above her head from one of the

A Lapp woman with her baby

tent poles. In a short while Jonas entered to give me the official welcome to his home, but his wife was busy tending her youngest child, seeing it did not suffer the fate of so many Lapp children—suffocation through being too firmly bound into its cot. After asking if his wife was ready to receive her guest, Jonas signalled me forward. There was reindeer meat to be eaten, and bread perhaps, there was "cheese" and a thick brew of coffee. (The Lapp is an inveterate coffee drinker.)

The Lapp is a likeable fellow, if a little strange to us. Whence he came no one is sure; it is thought that hundreds of centuries ago he followed the reindeer herds across the roof of the world from Mongolia, and where the herds wandered he had to follow, or perish. Gradually, as the various families settled in northern parts of Scandinavia and Russia, the particular herds they had followed became known as their exclusive property, and so the original ownership of the herds became established.

It is seldom that a Lapp will steal another's animal. He is permitted to kill, against starvation, but he must and does report his action to the authorities after cutting off the dead animal's ear to prove ownership. Each reindeer bears the mark of its owner upon its ear, while a few are "church marked"; with these a man buys his wife.

The Lapp's life is absolutely dependent upon his deer. They provide him with

"The Lapp is a likeable fellow, if a little strange to us"

bedding, clothing and thread; with milk, meat and shoes; with bone from which to make his implements; with a means of travel across a country practically roadless and alternately scorched by a 24-hour-day summer sun and lashed beneath an Arctic night. It is small wonder, then, that the Lapp will protect his deer with his life,

The laughing Laplander

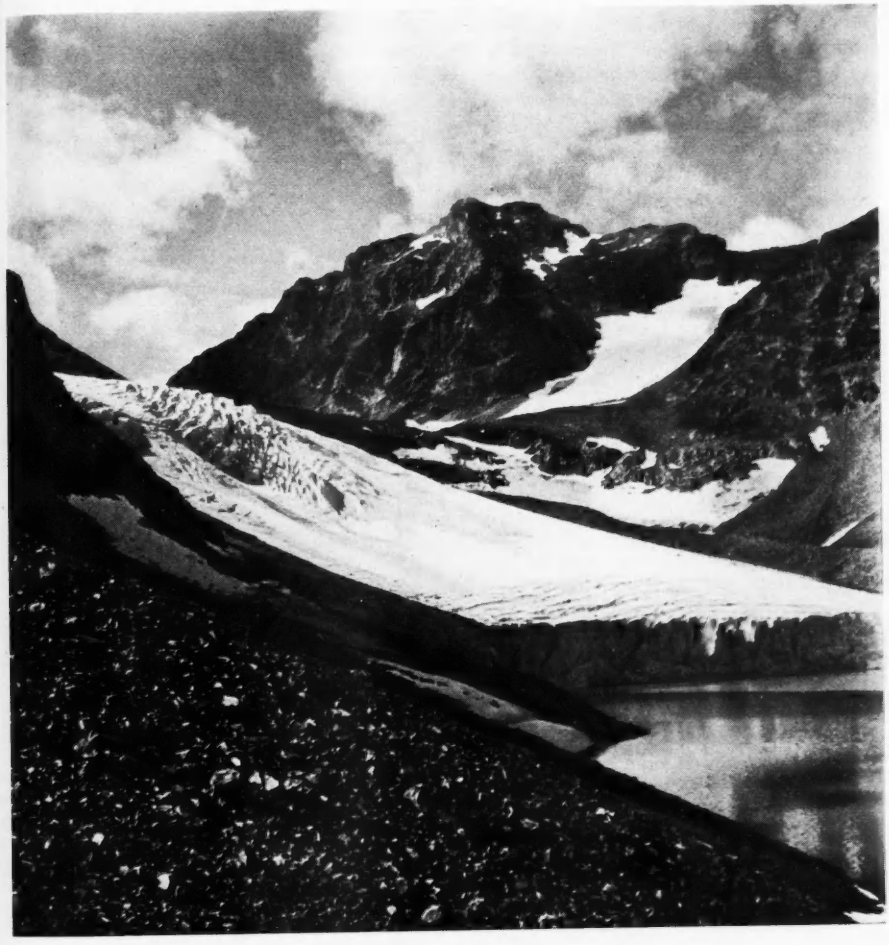
and love his helpmate in this task—the Lapp dog, the guardian against the wolf.

A Lapp's eyes will narrow with hatred at the mention of the word "wolf". When the snow is powdery and the wolf flounders in it up to its grey belly, making it an easy matter for a man on skis to overtake it, the Lapp sallies to lunge his "wolf-stick" into its heart or throat after breaking its back with a single blow; or perhaps to shoot the animal if the country is open. Jonas, my host, was the greatest wolf hunter in this part of the north. One dark day I accompanied him on a wolf hunt, but blizzard had blown the snow from the surface of river-ice which provided the prey with a hard surface on which to make their escape. I was told, however, that Jonas had killed seven wolves that winter single-handed, and, apart from earning the large Government bounty for each wolf killed, he had protected his reindeer from being pulled down in too great numbers.

It is a strange fact that, after centuries of reindeer-keeping, the Lapps should have learned only during comparatively recent times to milk their reindeer: it appears that only after a Lapp had watched a Swedish milkmaid milking her cow did it enter his mind to experiment with his reindeer, and so to bring the knowledge of milking to his people.

Jonas's wife was a busy woman; it was her job to milk the reindeer, to make the butter-cum-cheese which flavoured the coffee, to cure the pelts and the haunches after her husband had killed a beast with a sharp thrust of his knife in the base of its skull; and to care for his home comforts.

The Swedish Government provides schools for the Lapp children. At one school I visited the children (ranging from the age of four to fourteen) sang to me in English, Swedish and Lappska. As a general rule the children live and work under the tuition of Swedish teachers and



A glimpse across the Tarfala lake in the Kebnekaise mountain region

matrons in brick-built school houses during the winter when their parents are living in the forests. But when spring arrives, and the reindeer surge through the forest glens towards the mountains, the Lapps root up their tents and follow, and their children accompany them, sometimes to spend the summer months playing at "wolves-and-reindeer", sometimes to continue their studies in a "telt-cåta" (tent-house).

I marvelled at the manner in which Jonas found his way across this desolate land without a compass. One day, he told me how he did it: where the sun strikes the fir trees the bark is brighter; the longest spruce branches invariably point in a southerly direction; and more moss grows on the south side of boulders. By searching for these clues the travelling Lapp fixes the points of the compass during bad weather.

When the snow is too deep for walking he crawls, when he is hungry he searches for berries beneath the snow, and if he has no boat he paddles himself across rivers astride a log. Should he find a boat he may use it, but *he must leave it where he found it*. Boats are always left in pairs, one on either side of a lake or river. The Lapp must row across, procure the boat on the other side and tow it to the side he has just left before setting out to cross the water again. Only in this way can he cross the water and still leave a boat on both banks. Failure to do this might cause the death of another traveller wishing to cross the water; for death in Lapland is easy.

Jonas told me how, when his old mother had died the previous summer, her withered body was placed on a lake-island away from animals until the winter snows made it possible to transport her remains to church for burial. The Lapps are Lestadians, and especially strict in the north where a vengeful God strikes through the medium of blizzards, starvation, or epidemics which have been known to wipe out whole families; church is a serious matter. But such vast distances have to be covered by churchgoers and priests that services are few and far between for many Lapps, and I was told it is not uncommon for a man and a woman to be married by the priest upon the same day that their child is baptized.

At one church service I attended, the men sat on one side, the women on the other, and the dogs at the back—for the Lapp sees nothing sacrilegious in taking his furry friend to prayers. On several occasions during the service pandemonium broke out at the back of the building as snarling beasts threw themselves at each other's throats; the congregation calmly left their pews to separate the snapping animals before continuing the service!

But the burials of the Lapps at Jukkasjarvi must be very different, for there, 150 miles farther south, the Swedish government has built Lapp "hemmets" or institutes, for the comfort of the aged poor. These "hemmets" have hot and cold water in bedrooms and bathrooms, sprung beds, electric light and central heating; yet, for all these free comforts, the Lapp longs for the marshes and the forests, the tundra and his own tent. This he pitches in the track of the restless, roaming reindeer herds, building it approximately 9 feet high by lashing two lengths of pine wood together at the top to form the framework. These poles are joined together with two short lengths of wood about 18 inches below the apex of the pole. The four poles make a rectangle, covering 60 feet of ground. Over the framework a double layer of woven blanket is tied and weighted

A Lapp girl from the Tarradalen valley

down at the bottom with logs. At one side there is a flap about 4 feet high. The heat rising from the fire prevents the snow from entering the hole at the top, and, with its thick outer covering, the tent is surprisingly warm, and I was sorry to have to leave Jonas's tent home and board the motor bus again for Kiruna.

Notes of the Month

THE LIFE OF A GLACIER GRAIN

NEW methods have recently been employed for studying the internal mechanism of glacier flow. A party of Cambridge scientists under the leadership of Mr G. Seligman, the well known snow expert, installed a laboratory for physical and petrographic work in an ice grotto on the Jungfraujoch (Switzerland), at an altitude of over 11,000 feet. The laboratory served as a basis for extensive researches whose object might be formulated as the tracing of the life history of the average ice crystal from the moment of its deposition on the surface of the upper regions of the glacier, through its flow to the valley to its final re-emergence and melting on the surface of the glacier tongue. This journey can be divided into three stages: first the settling of the fallen snow under its own weight and under the influence of melting and refreezing, second the transformation of the snow thus compacted into glacier ice and third the alterations which the ice itself undergoes in the course of some hundred years' travel. In the first stage rapidly alternating heat and cold waves cause the snow crystals to grow to about ten times their original size and to become orientated in line with each other. During the second stage the size of the crystals remains nearly stationary, as the daily temperature variations can no longer reach them and they are merely subjected to slow annual temperature fluctuations. On the other hand, being in comparatively loose contact, they begin to turn round and move relatively to one another under the influence of flow until they are orientated completely at random and packed as closely as crystals in a metal. Hence, in the third stage the crystals are too firmly interlocked to permit their relative motion, and instead respond to the strain of flow by a

process of selective growth. Crystals whose orientation relative to the direction of flow is particularly favourable grow at the expense of their neighbours and simultaneously undergo deformation. When the deformation has exceeded a certain limit other crystals begin to grow at the expense of the first, becoming themselves deformed and so on. As a result, the average size of the crystal increases with the length of the glacier, and a snow grain of the size of a pin-head may become as large as an orange by the time it reaches the glacier snout.

The expedition investigated numerous other problems relating to glacier formation and glacier structure, and brought home a wealth of experimental material. L. L.

(*Perutz and Seligman, International Research Station, Jungfraujoch*)

QUICK-SET RESINS

TWO applications of the new quick-set resins are announced from America. Quick-set resins are liquid phenol-formaldehyde condensation products which harden without heat and pressure, by the addition of an accelerating agent. When used as an adhesive, quick-set resin forms an insoluble, infusible, transparent joint of tremendous strength; it can be used for joining leather, wood, casein and cellulose plastics and other materials. It can also be used as a varnish, or for paper and cloth lamination. As the hardening of this cement is strictly a chemical reaction, air-drying is not necessary.

Another variety of quick-set resin is used for producing castings in moulds of rubber (latex), lead, and glass. After casting, the resin will harden itself in 24 hours without heat or pressure.

Scientific American

THE ELASTICITY OF RUBBER

THE elasticity of rubber is one of its most remarkable, and most useful, properties. One may contrast the behaviour of a strip of rubber (e.g. a piece of a toy balloon or a rubber band) with, say, a strip of metal of similar size and shape. It is quite easy to stretch the rubber to several times its original length, and, what is more important, the rubber will return to its original length when released. A force which doubles the length of the rubber will hardly produce any noticeable increase in the length of the metal strip. Larger forces will stretch the metal visibly, but it is quite impossible to stretch it as much as the rubber, because it breaks. An extension of only a few per cent will cause a permanent deformation, so that the strip does not return to its original length when the force is removed. A more subtle difference is disclosed when the effect of temperature changes is studied. A rise in temperature makes it *easier* to stretch a metal, but *more difficult* to stretch rubber, i.e. a larger force is required to produce the same extension.

The elastic properties of metals, and most other substances, are governed by the forces between the atoms or molecules of which they are built up. These forces resist any change in the positions of the atoms relative to one another, and the material as a whole therefore resists attempts to change its length, or to distort it in other ways. It seems, however, that the elasticity of rubber is controlled by other factors. Rubber is composed of long, flexible, chain-like molecules, which normally exist in a more or less coiled-up condition. When the rubber is stretched, the long molecules are simply uncoiled. This process is not resisted to any great extent by the intermolecular forces, and allows a very great increase in length. But uncoiling *is* resisted by the thermal motion of the atoms, which tends to make the uncoiled chain revert to the coiled or "jumbled" condition (which is

statistically more probable). This, therefore, is the origin of the greater part of the elastic force in stretched rubber. A mechanism of this kind also explains why rubber is less easily stretched at high temperatures. In fact, the theory predicts that the force required to produce a given extension will be proportional to the absolute temperature, and this is fairly well confirmed by experiment.

Independent evidence about the internal condition of rubber is given by X-ray crystal analysis. Stretched rubber gives X-ray photographs somewhat similar to those from crystals, whereas unstretched rubber does not. The photographs indicate that the stretched material contains a regular arrangement of uncoiled chains, parallel to one another, and to the direction of stretching.

Finally, it may be mentioned that some other, though by no means all, substances with long chain-like molecules have rubber-like properties. These include the various synthetic rubber substitutes developed in recent years.

J. N. A.

(*Mark and Meyer, Vienna*)

A CARCINOGENIC PARASITE

PARASITES, in addition to the direct effects which they produce in their host—starvation, destruction of tissues, and inflammation—often give rise to indirect effects as well. Perhaps the most familiar case is the degeneration of the sexual organs of the host, usually referred to as parasitic castration. A very remarkable example of such indirect effects has recently come to light. It has been found that a certain chironomid (a family of which the larvae are familiar as bloodworms and the adults as gnats), which during its larval life is an ecto-parasite of may-fly larvae, hanging on to their thorax and sucking their blood, induces the formation of malignant growths in its host. The first stage consists in the formation in the thorax of a tumour which closely resembles the sarcomata of higher animals; this is followed by a malignant leukaemia, in which the blood corpuscles rapidly multiply at the expense of all the other tissues. Frequently the second stage does not begin until after the parasite has hatched from its pupa and flown away. The mayfly's development is inhibited, and eventually it dies, after becoming reduced to a mere skin filled with blood in which the corpuscles are so numerous that it has become, in the author's graphic phrase, a "*purée cellulaire*".

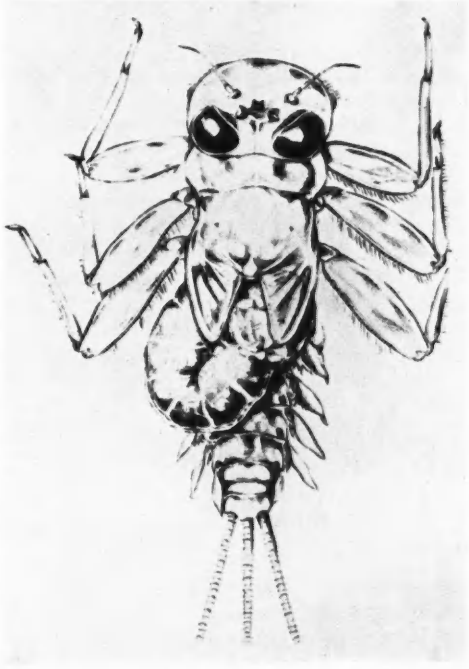


Fig. 1. A may-fly larva, with the Chironomid parasite attached in its usual position beneath the wing-buds

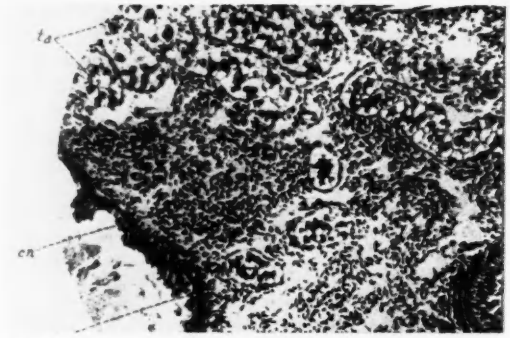


Fig. 2. A section through the fat body of a larva which has recently borne a parasite. ta, *degenerating lobules of fat-body.* cn, *blood space filled with a mass of proliferating leucocytes.*

From "Archives de Zoologie Expérimentale et Générale", Tome 81, *Fasc.* 1. *Le Soudier, Paris.*

The formation of tumours or galls in response to parasitic attack is of course a common phenomenon, but such growths are normally inflammatory in nature and always benign. Malignant tumours have indeed been very seldom described in invertebrates, and this case seems to provide the closest parallel yet found to the cancerous growths of vertebrates. Its peculiar origin should therefore be of interest to the pathologist as well as to the entomologist.

D. A. W.

(*Codreanu, Cluj, Rumania*)

LOOKING INTO THE KNEE JOINT

In recent years, a great advance in diagnosis has been made by the design of apparatus for the inspection of diseased organs of the body without an open operation. This method of endoscopy ("looking inside") has been developed for organs such as the stomach, chest and bladder (gastroscopy, thoracoscopy and cystoscopy) and now Dr Vanbel of Frankfort has described an arthroscope for the inspection of the knee joint. Many quite different diseases of the knee and its surrounding structures have very similar symptoms—pain, limitation of movement and so on—and exact diagnosis is sometimes difficult. X-ray may help but early disease of the bones cannot easily be recognized and, moreover, the ligaments and membranes of the joint itself can rarely be seen on the X-ray film. With the arthroscope, the patient needs only a local anaesthetic and a small tube inserted into the joint. The joint can then be washed out with sterile fluid and a small quantity of sterile air injected to distend the joint and aid inspection. By means of a special optical and illuminating arrangement, the operator can then examine the structures within the joint. By this means Dr Vanbel was able to diagnose several difficult cases of arthritis of the knee and in many instances the diagnosis completely altered subsequent treatment.

J. Y.

(*E. Vanbel, Frankfort*)

A SUGAR SUBSTITUTE

The rationing of sugar will give an impetus to the production of other compounds which have the property we call sweetness. The best of these substitutes is orthobenzoic sulphonimide, which is commonly called Saccharin. It was first discovered by Remsen and Fahlberg in 1879. Saccharin is about 500 times sweeter than sugar, and its sweetness is perceptible even in a concentration of only 1 part in 10,000.

Saccharin is produced commercially from toluene, and adequate supplies of this, as a

by-product of coal-tar distillation, are readily available. It is a white, crystalline solid of fairly high melting point, and is only sparingly soluble in water. Its solubility can be increased by making the sodium derivative, and its sweetness can be still further increased by the addition of a similar compound—dulcin (para-phenetole carbamide). Saccharin is already used in the foodstuffs' industries as a sweetening agent, and it is also used medicinally in the diet of diabetics. Cane sugar is a carbohydrate, and its dietetic value lies in this property. Carbohydrates, by their combustion in the body, supply energy. Saccharin, on the other hand, has no value as a foodstuff, and though it can replace sugar successfully as a sweetening agent, the diet should, if possible, be supplemented by carbohydrates. Starchy foods are degraded in the body into sugars, and are valuable for this reason; so are jams, sweet fruits, honey, and in fact any food which contains sugar.

K. T.

The Ultra Perceptive Faculty

[*We are glad to publish Dr Hettinger's account of his research; but we must point out that it differs from most of the scientific news published in* Discovery, *since it is not part of an established and accepted field of knowledge. By the nature of the subject, the difficulties of obtaining a completely objective method are enormous; and at present, while recognizing the ingenuity and integrity of Dr Hettinger's work, most scientists will not be convinced of the existence of the "ultra perceptive faculty".* THE EDITOR]

By Dr John Hettinger

Is the perceptive ability of the mind limited to sensory and intellectual perception, including intuition, or does the perceptive faculty extend beyond the ordinary range? In this article I will give a short account of the research which I carried out at King's College, London University, over a period of several years,* as a contribution towards the solution of this problem.

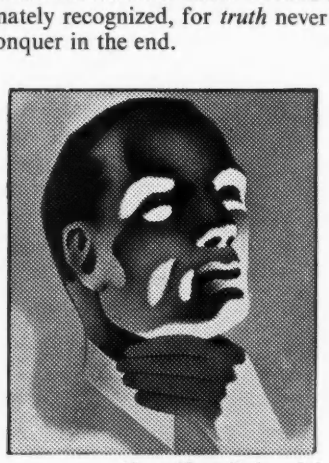
The work was commenced in 1933 before Rhine published his experiments on extra-sensory perception by means of Zener cards, and I am anxious that my own work shall not be considered in the light of that which transpired since Rhine's publication, namely, that his experiments could not be repeated. In fact, for the sake of curiosity, I tested professional mediums on Rhine's experiments, but the results were entirely negative. There is no comparison whatsoever between our respective researches. Rhine used a number of students alleged to possess the ability of sensing certain definite designs on five different cards without the use of the normal senses, an ability stated to have been gradually lost by them. In contradistinction thereto I made use of

* Dr Hettinger's *statistical* and *time-factor* experiments were embodied in a thesis which was successfully presented for the Ph.D. degree of the University of London. This is probably the first thesis yet admitted by a British University on this particular subject.

professional sensitives, and the things perceived, while normal perception was precluded, were in no way predetermined and extended over an unlimited range of all kinds of impressions. Professional sensitives retain their faculty for many years, so that my experiments can be repeated by anyone who may wish to undertake them. The importance of this point need hardly be stressed, it being generally recognized that all proofs claiming to be scientific must be capable of verification by repetition.

Misnomers are apt to mislead. The expression "extra-sensory perception" is an example. What a "sensitive" appears to perceive, and an ordinary individual cannot, is not only "extra-sensory" but also "extra-intellectual" and "extra-intuitional", if I may use these expressions. Normal perception comprises sensory as well as purely intellectual and intuitive perceptions and, in order to denote that we are concerned with a perceptive faculty which goes beyond this normal range, I suggest using the expression "ultra-perceptive faculty", the prefix "ultra" meaning "beyond the ordinary", as in the case of "ultra-violet", for instance, which denotes the range beyond the ordinary violet.

I ought also to mention that this research has nothing to do with the investigation of the spiritualistic claims. Indeed, the results obtained neither prove nor disprove these claims. On the other hand, they point to a complete vindication of the existence of *mental* mediumship, a problem which has been much debated in the past and a general verdict upon which has been greatly delayed, mainly by the wrong approach to its investigation and by over-confident assertions and interpretations, as well as by the evidence put forward in its support being confused with that of *physical* mediumship, frequently found fraudulent, even by the spiritualists themselves. Reasonable *scepticism* has played and is still playing a useful part but, as the history of all sciences shows, wherever there is a modicum of truth that truth is bound to be ultimately recognized, for *truth* never fails to conquer in the end.



Messrs Allen & Hanburys Ltd

When your throat is tired, overstrained, tickly, suck an Allenburys Pastille. They're delicious, and effective.

1. THE SENSITIVE: "Irritation *of the neck by the* collar."

It will be seen from the account of the research which will now follow, that, irrespective of any theoretical interpretation, the special ability hitherto alleged to be possessed by mental mediums is undoubtedly entitled to be accepted at least as a probable fact which deserves the careful attention of the sciences concerned.

There are different forms of mental mediumship, and previous personal acquaintance therewith, in fact since about 1928, decided me to concentrate the research on the alleged power generally referred to by the misnomer of "psychometry". In virtue of this power a "psychometrist" seems to be able to receive all kinds of impressions, sensory, emotional or purely intellectual, with respect to a distant unknown person while "psychometrizing" an object belonging to that person by mentally concentrating thereon,

under conditions which completely preclude their being received by the normal means of perception.

Over 150 subjects participated in these experiments, which were carried out with the assistance of two professional sensitives. The procedure was as follows: The articles obtained from the subjects were placed in separate sealed envelopes and taken by the experimenter to the residence of the sensitives. During the "sitting" the

FIRST—
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IT REBUILDS SKIN TISSUE! Four years ago doctors first noticed that when one certain vitamin was applied to wounds and burns, the skin healed very quickly. It was learned, too, that when this vitamin was lacking in the diet, the skin became extremely scaly. Then scientists discovered the reason. This "skin-vitamin" is essential for rebuilding skin tissue. Without it, cells flatten, oil glands dry up, under-tissue becomes shrunken. And the skin suffers in health and beauty.
THEN—
we tested it in Face Creams for over three years
WHAT THE MICROSCOPE SHOWED
At Pond's request leading biologists put the "skin-vitamin" into Pond's Creams and studied the effects. Research continued for 3 years. When Pond's Cream containing the "skin-vitamin" was applied daily for 2 to 3 weeks, the skin improved remarkably — became healthy, smooth, clear. The microscope showed that oil glands were functioning again, flattened cells and tissues were normal.

Messrs Pond's Extract Company Ltd

2. THE SENSITIVE: "Progression".—"*A little bit sad, had sad news, someone has been crying.*"—"*I looked at something until my eyes ached.*"

(*Notice the words* "FIRST"..."THEN")

sealed envelopes were submitted to the sensitives, one by one in turn. One of the sensitives handled them but the other one did not; she merely concentrated on the envelope, which was laid on the table next to her.

The first experiments were directed to extensive *statistical* tests of the probability of the existence of an ultra-perceptive faculty. These experiments led to an important finding as regards the "time factor", which finding, in its turn, led to the discovery of a new method of psychological investigation. I will deal with these three experimental steps in their chronological order.

The Statistical Experiments

These were carried out by means of "control methods", which were gradually evolved from one another with a view to improvement. They all had the following factor in common: in each test the items perceived by the sensitive in connexion with the subject whose article she psychometrized were presented to that subject for *identification* mixed in some form or other with an equal number of fictitious or "control" items, consisting of items given to another subject, the subjects not knowing which was which. As a rule twelve items were given with each article, which very seldom concerned the contents of the envelope, referring almost invariably to characteristics, emotions, actions, events, etc., associated with the subject to whom the article belonged. By using such a "control" method the statistical calculations were greatly simplified and the meaning of the results could be more easily comprehended.

The statistical experiments were applied to 623 tests which yielded altogether 6631 items. Of the total

$$2 \times 6631 = 13{,}262$$

(proper items + control items), 4483 were accepted by the subjects as being applicable. Of these 2570 belonged to the subjects and 1913 to the "control". By using the well-known formula of the standard deviation

Hard lines on father, or the family, waiting between baths for the water to get hot. And hard lines on busy women to have to get through their jobs with miserable supplies of Hot Water—carrying and shovelling to get it, or boiling pathetic kettlefuls, tied down while they wait for it. Thousands suffer this way, yet needn't. Listen.

Gas Light & Coke Co. and the London Press Exchange Ltd.

3. THE SENSITIVE: "*I am impatient with someone who is* very slow; *a* business condition."

of a proportion, viz. $\sigma_p = \sqrt{\frac{p \times q}{N}}$, in which N is the number of trials, p the proportion of successes and q the proportion of failures, and the formula of the probable error of a proportion $PE_p = \frac{2}{3}\sigma_p$, the result obtained was found to be well above chance expectation, viz. 14·6 times the probable error, a figure which denotes *significance*.

If an ordinary coin is tossed 1000 times we should expect, within small deviations, approximately 500 "heads" and 500 "tails" but if the deviations from 500 are comparatively large, this is a result which indicates that the coin is probably not an ordinary one, but is so constituted as to tend to fall one way far more often than the other. Similarly, in these statistical

Messrs John Knight Ltd.

4. THE SENSITIVE: "*I felt I wanted to take my* pulse."

experiments, assuming the sensitive had been merely guessing, the subjects should have accepted, within certain small deviations, 2240 items given to them by the sensitives and approximately the same number of "control" items. However, the figures obtained deviate substantially therefrom, viz. to the extent of +330 and −327 respectively, which leads to the conclusion, analogous to the second example in the coin tossing, that *there must be something characteristic of the sensitives that enables them to score higher than by mere guessing*.

Time-factor Experiments and a Psychological Finding

While the statistical experiments were in progress many subjects reported that quite a number of items received by the sensitives concerned events which occurred *after they had parted with the article*, and that some were applicable *at the actual time of the test*. This led to a further series of tests, with a total number of items of 1658, of which 667 were accepted as applicable within 2 *weeks* before the time of the test. Of these 165 were found applicable within 5 *days* of the test, 217 *on the day* of the test, and 66 *at the time* of the test. Two examples of events accurately perceived will suffice to show how specific some of them were: (1) "Owner reads some papers I want to call proofs"; (2) "A pile of shillings as if saved for some purpose." These were accepted as applicable to the subject at the actual time of the test.

The time-factor experiments thus revealed a most interesting fact in the study of the ultra-perceptive faculty, namely, that the *recency* of the item perceived is probably an important factor in this form of perception. This fact, considered in conjunction with the generally accepted fact that every personal experience is stored in the subconscious mind, whether it happens to emerge or not into the conscious, is

Messrs Rowntree & Co. Ltd.

5. THE SENSITIVE: "*Someone interested in* Dairy *work*."

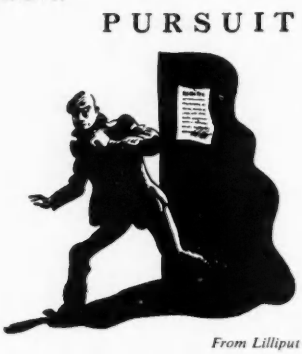
self-suggestive of a plausible explanation as to what the *main fact* in the exercise of the ultra-perceptive faculty, as exemplified by

psychometry, might be. The explanation may be postulated as follows: *When a sensitive concentrates on an article belonging to a subject, a mental rapport is established between the sensitive and that subject, and whatever is perceived by the sensitive in virtue of the ultra-perceptive faculty is present in, or is accessible to, the psychological make-up of the subject at the time of the test.*

A New Method of Psychological Investigation

Investigators of the ultra-perceptive faculty have constantly felt the need for some method which will enable them to investigate this faculty at will, but no method hitherto proposed has proved satisfactory. As a sequel to the above statistical and time-factor investigation a method was discovered which, besides satisfying the need that was felt, seems to provide a new method of psychological investigation.

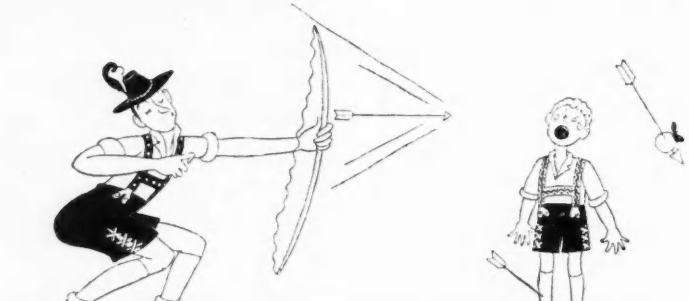
According to this new method, the subject is asked to obtain any illustrated paper he fancies but not to look at its contents until the prearranged time of the test, when he shall start perusing it, quite normally, without any effort at concentration, indicating on the paper the time he peruses each page or contemplates each picture; during the same time the sensitive, miles away, "psychometrizes" an article of the subject, the experimenter writing down each item given by the sensitive, and against it the time the items are actually given by the sensitive.



From Lilliput

6. THE SENSITIVE: "*I just felt as if someone came behind me and frightened me; some steps.*"

From the very outset the experiments proved highly successful, especially with respect to the relationship revealed to exist between the illustration or matter read and the statements made by the sensitives *at the very time the subjects were contemplating the pictures or perusing the text.* Thirty-eight one-hour tests produced 3513 items, of which 322 were accepted as applicable personally and 585 were appli-



From Lilliput

7. THE SENSITIVE: "*I cannot sit too long with that.*" "*Something I want to open, I have two cords.*"

8. "*Something spread on the floor; I have to go down on my knees to deal with.*"

cable to the reading and pictures, viz. 9·1 and 16·6 % respectively. The number of items concerning the reading and pictures thus exceeded the number of personal items by 82 %.

Use was made of a large number of illustrated periodicals; of most of the London daily newspapers; also of technical papers. There are numerous instances of complete correspondence between the pictures and the items perceived; perception of faintly visible details, of colours, sound, smell and taste, of feelings and emotions; also distortions, the reason for which is easily discernible; and many other examples of thought-provoking relationships. The correspondence and relationships between the pictures and the items given by the sensitive at the very time the subject is contemplating a particular picture are sometimes most remarkable.

Here are a few examples out of many hundreds.

Picture of a large camera. *Sensitive*: "A large camera and bright light."

Picture of an aeroplane. *Sensitive*: "Peculiar sensation. I think it is a sensation of flying."

Picture of a cart-horse entitled: "Biggest horse in the world." *Sensitive*: "Some admiration for large cart-horses."

However staggering examples of such absolute accurate reproductions may be, one soon realizes when perusing the collection obtained by this research that the impressions which seem to be somewhat "veiled" are the most interesting ones from a psychological point of view. For instance: A *picture* of the burning pavilion at Blackpool was perceived by the sensitive as follows: "Something bright red, a distance away, reflecting red light," and the *picture* of a "Sight-seeing guide" entitled "And here are the high Spots", produced the impression: "A mountain in the distance and boys roped together going up."

And here are two examples from non-illustrated *reading* parts:

Sensitive: "Peculiar noise going on here." The subject was then *reading* a paragraph concerning 500,000 cats.

Sensitive: "Sitting in one position too long—caused shoulders to ache." At that time the subject was *reading* the following title and subtitle: "Rain spells ruin to these pavement artists. He's sat in the street for seventeen years."

These examples and the illustrations accompanying this article speak for themselves. Any comments on my part would be superfluous.

It will be seen that the findings of this research lend themselves to a new method of psychological experimentation, viz. by the ultra-perceptive reaction of a sensitive while psychometrizing an article belonging to a subject. Is this reaction different in the case of people of different temperament, character and ability, of children and adults, and of persons of normal and abnormal mind? Will the impressions of the sensitive be different if the same set of pictures were perused by these different people? Could any useful information be obtained for a psychotherapist from the conscious or subconscious of a patient by comparing the results of his psycho-analysis with the corresponding impressions of a psychometrist, assuming the psycho-analysis and the psychometry were carried out simultaneously? Could the method conveniently be used to improve the ultra-perceptive faculty of a sensitive by drawing her attention to the discrepancies between the statements she made and the actual pictures perused by the subject? These few examples, which are almost self-suggestive, will suffice to show the wide range of applications in connection with which the method above expounded might be usefully employed.

I myself propose to continue the research in these and other directions, but I trust that many others will realize the importance of these findings and contribute their own share by systematic researches in whichever direction they think they can be most useful.

[*For permission to reproduce the illustrations in this article, this author is greatly indebted to:* 1. *Messrs Allen & Hanbury Ltd.* 2. *Messrs Ponds Ltd.* 3. *Gas Light & Coke Ltd.* 4. *Messrs John Knights Ltd.* 5. *Messrs Rowntree Ltd.* 6, 7, 8. *Lilliput.*]

How a Town Once Conquered Drought

Of the numerous ports on the shores of the Black Sea one of the most favoured is Feodosia or Theodosia, on the south-east corner of the Crimea. It is never ice-bound; it enjoys direct communication with the mainland, and is protected against the winds, from east, west and south. Its chief drawback is the poor water supply.

The advantages were appreciated as long ago as the sixth century before Christ, when Greeks from Miletus established a trading station at Ardadba, as the place was called in the barbarian tongue, and renamed it Theodosia. The situation was so favoured that the wealth of the colony grew rapidly and reached its zenith about the year 393 B.C. under Leucon I, who made it a great centre for the export of wheat to Greece, especially to Athens. Probably the merchants supplemented this trade by dealing, from the interior, in other commodities such as honey, fur and hides. They struck coins in copper and silver in the fifth and fourth centuries B.C. In a beautiful climate, the inhabitants took full advantage of the fertility of the soil, and the splendid sandstone amphorae that have been dug up in numbers bear witness to the existence of flourishing vineyards, while the discovery of pottery, terra-cottas and very beautiful Greek jewellery all point to a high and flourishing civilization. In those days the place must have enjoyed an excellent water supply, for the remains of no less than one hundred and fourteen fountains have been traced in the town.

The city passed through several vicissitudes. We hear of it becoming part of the Bosporan kingdom and then begging the protection of Mithradates VI, King of Pontus. Then it appears as tributary to Rome.

During the stormy centuries of barbaric

invasions, Theodosia must have suffered, with the rest of the Crimea, at the hands of the Goths, Huns, Khazars, Byzantines, Kipchaks and Mongols. In the ninth century we find it alluded to under the name of Kafa.

Then the Venetians established posts along the Crimean coast, but in the thirteenth century the Genoese drove them out and in 1266 established themselves at numerous ports, including Kafa, or Capha, as they wrote it. These enterprising merchants restored the long-forgotten prosperity of the old town, which became an important depot on a trade route extending to China. It became the seat of a bishopric and the most important port on the northern coast of the Black Sea. The Genoese built a splendid citadel, which quite recently was still standing, and imposing walls as protection against the raiding Tartars. The population is believed to have been about eighty thousand souls.

They set to work to improve the water supply, which had fallen into decay and was quite inadequate for so flourishing a community. They built many cisterns in the town itself, and on the surrounding heights collected water in artificial reservoirs, bringing it down through a system of earthenware pipes to different parts of the city. It was conveyed to the numerous fountains, the overflow conducted by smaller pipes to cisterns in almost every house.

But the climate was dry. There were no local streams and the rainfall was inadequate for the needs of so big and populous a city as Theodosia-Kafa must have been. Water remained precious. For its control the Genoese set up a Water Board, in 1449. The staff consisted of an inspector, *Mecamira seu perquisitorem aquarum*, at a salary of thirty aspers a month, and a surveyor, *custodem seu superstantem aquarum*, at sixteen *sonms* a year, whose duty it was to maintain the existing pipelines and to construct new ones. A *sonm* appears to have been equivalent to about ten or fifteen shillings in gold.

There were penalties for the abuse of the water, including a fine of twenty-five aspers upon any citizen detected in polluting it. Among other details there are records of a curious due charged upon the captain of every square-rigged vessel entering the harbour. He was obliged to provide one boatful of stones.

In the fifteenth century the flourishing city was once more ruined by barbarian invaders. In 1475 the Ottoman Turks captured the place. These inveterate deforesters contributed to the reduction of the already inadequate rainfall and allowed the pipes to be broken, clogged, and fall into disuse. At the close of the eighteenth century there were only thirty-three fountains left standing, of which five were in operation. So much damage was permitted through ignorance and neglect by a people who stand out as perhaps the greatest connoisseurs of drinking water.

So it is not surprising that when the Russians took the place in 1771 they found it suffering from an acute drought, the inhabitants being dependent on such meagre quantity of water as they had been able to store in their cellars.

In 1883, on the centenary of the annexation of the Crimea, the Russian Duma decided to establish a modern water supply for the port, and an engineer named Zibold, was instructed to accelerate an extensive programme of afforestation which had been begun in 1871, and to tap any available springs on the surrounding heights. A big area was successfully planted and by 1888 a spring on the high ground had been found at a place called Aguer Mikh, tapped, and piped down to the town, yielding about a hundred thousand gallons a day.

During these operations Zibold made a remarkable discovery. He revealed the existence of the long-forgotten elaborate system of sandstone pipes, 2–2½ inches in diameter, which had once supplied the numerous fountains of Theodosia. But whence did they draw their water? The key lies in that strange harbour-due levied

upon shipping entering the port. For what were those stones required?

Their purpose was revealed by Zibold when he traced the old pipelines up the mountain side to the heights some thousand feet above the sea. All around was dry and rocky, with no trace of springs. But he found some curious things; great masses of broken stones, some hundred feet long by about eighty broad, standing about thirty feet high. Over a distance of two and a half miles he found no less than thirteen of these strange constructions, which were evidently the work of human hands. But why had so much labour been expended?

Zibold quickly perceived them to be huge condensers. In his report to the Ministry of Agriculture he pointed out that these piles were built of pieces of stone measuring from two to four inches across. Atmospheric moisture, penetrating the interstices, would be chilled and condensed, to trickle off to the heads of the pipelines. They were situated in an ideal position to catch the hot, moisture-laden breezes off the Black Sea.

Basing his calculations upon the dimensions and number of the pipes discovered and on the number and size of the condensers, and the fact that the operation of condensing would continue for about eight hours in the day, Zibold worked out that each of the condensers would be capable of yielding about one and a half million gallons per day, so that the reservoirs and cisterns supplying the hundred and fourteen fountains could have been supplied with nearly sixteen million gallons of fresh water per day, apart from the scanty rainfall. The city must indeed have been populous.

The masses of stones were so overgrown with vegetation and clogged with the rubbish of centuries that Zibold recommended the Ministry, rather than attempting to clean them up, to build new ones, and secured the necessary credit for an experimental condenser. This was erected, but the trial resulted in failure. The experiment was not repeated, as political circumstances prevented further work.

The story of the medieval water supply of the town was written nearly sixty years ago by a local schoolmaster, V. K. Vinogradoff, who had the forethought to send a copy of his pamphlet to the British Museum. The title is *Feodosia, Istoricheskiy Pocherk*. The preface is dated 7 April, O.S., 1883, but the Museum copy is of the second edition, dated 1902, from Ekaterinodar. It was issued in conjunction with the centenary celebrations.

The author's son, the late M. V. Vinogradoff, was a civil engineer and much interested in the problem. Not long before his death he told me that he could remember how, as a boy, he saw the last of the fountains functioning, carefully guarded by an armed policeman. He told me also how in parts of Turkestan he had come across similar piles of stones. When he asked the natives what they served for they always replied that no man knew, but they supposed them to be the tombs of ancient peoples. He made some excavations and in every case found pipes leading from them. In all cases the country was arid, though reputed once to have been a wheat-producing district. He told me too that he had satisfied himself as to the reason of Zibold's failure, and hit upon the factors essential to success. In proof of this he had erected a condenser in the province of the Don Cossacks and in it succeeded in collecting the moisture from the air without machinery or chemicals. He obtained a continuous flow of water, the volume of which was greatest during the hours of highest atmospheric temperature. Then came the revolution.

How priceless such a system in hot and arid countries would be, yet how easy to erect in the neighbourhood of the sea, such as the northern coasts of Africa, the Levant, the Red Sea or the Persian Gulf! It might restore prosperity to desiccated cultures and convert the desert to the sown. Those thirteen great condensers still stand upon the heights above Feodosia, visible from the sea, dumb witnesses of an ancient past when men had the wit to make use of the processes of nature in a manner which a more sophisticated age has forgotten.

MALCOLM BURR

How Much Does it RAIN?

By Reginald M. Lester

THE study of rainfall irregularities has to be considered mainly from two viewpoints, (*a*) the country's water supply, and (*b*) weather forecasting.

The available yield of a British watershed is estimated from what is called "a minimum rainfall period", and is arrived at by taking four-fifths of the annual average rainfall over the given area as the annual precipitation to be expected during a period of three consecutive dry years, and then subtracting from this amount an allowance for losses from evaporation and other causes. Close attention has to be paid by water engineers to evaporation losses, which vary so much in different districts, according to the geology, topography, and vegetation, and which are naturally greater in areas that enjoy maximum sunshine than in the cloudier localities. The mean annual loss by evaporation over Great Britain is just over 14 in. In the north of England it varies between 12 and 14 in., whereas in Devon and Cornwall it rises to about 20 in., and in some parts of these counties to as much as 25 in.

Continuous stream gaugings over long periods provide a valuable source of information to the water engineer, who has to consider the best way of meeting extreme conditions of drought in his design of impounding schemes.

The minimum dry weather flow of British streams usually reaches its peak about the end of September, just before the normal autumn rains begin. Stream flow, of course, is more uniform in flat country and pervious areas, than where the locality is hilly and impervious and the streams frequently become dry in summer. Less storage is consequently required in the former case. This flow is important in estimating the required reserve storage capacity, but there are at present insufficient records during drought years, although further much-needed research is also proceeding in this direction. In normal rainfall districts, about six months' reservoir storage in English rivers is required to secure the flow of the three driest consecutive years. An artificial reservoir impounds surplus water in wet periods for use in dry ones, and accordingly balances to a great extent the natural fluctuations of flow.

If weather forecasting had advanced at the same rate as so many other sciences to-day, forthcoming rainfall and drought periods could be foretold and provisions made to meet these contingencies. The problem of rainfall, however, is still only half understood by meteorologists themselves.

Although it has been established that large areas of rainfall are associated with temperature differences in the upper air, that does not in itself explain the rain. The difficulties are further increased owing to the fact that surface temperatures are misleading, and the temperatures of the upper strata are often inferred from indirect evidence. When there is instability in the upper air temperatures, rain will fall even though the barometer is showing no tendency to drop, and the general forecast may be "settled". Local features, such as hills or coastline, will particularly affect rain of this type, and the rain in the warmer sectors of air is usually intermittent, and mainly in the form of drizzle. Surrounding areas in close proximity may continue fine and sunny, and it is so far almost impossible to forecast such local rainfalls.

A frequent source of showery weather

is the passage of a cold current of air over a warm area, and where these shower areas drift inland they often develop into a period of continuous heavy rain.

Dr Glasspoole, the eminent British meteorologist, is of opinion that there is a real relationship between the weather of the British Isles and that of eastern America. A general deepening of the low pressure system on the North Atlantic tends to result in strong south-west winds over this country and increased rainfall, whereas it would result in more northerly winds and lower rainfall in eastern America.

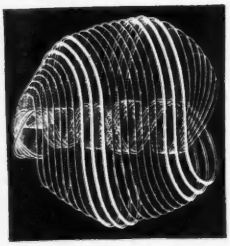
This inverse relationship is very evident in collected records over the period of years from 1838 to 1932, the dry and wet periods over Britain and America showing opposite tendencies in a most positive manner. The discovery was of such interest that the Institute of Civil Engineers set up a Floods Committee to carry out investigations into America's rainfall, year by year. Rainfall records in the U.S.A., however, are neither as complete nor cover such a long period back as those of the British Isles, but those that are available confirm the inverse ratio already mentioned. For instance, the rainfall in the north-eastern States for the two consecutive years, 1930–1, was the lowest on record, while the same period was well above normal at the selected British stations (Greenwich, Chilgrove, Oxford, and Spalding).

The remarkable variations of rainfall in this country are not fully realized until one glances through the British rainfall statistics of the Meteorological Office. For example, the average annual number of rain-days at Shoeburyness, Essex, is 149, whilst at Ben Nevis, Inverness, it is as high as 259, and at Stornaway 263. Ireland, as may be expected, runs a close second in maximum rainfall, Ballynahinch Castle, in County Galway, recording 262 rain-days. Even in places a few miles apart, the rainfall varies very much.

The least rainfall totals are always in the regions of the Thames Estuary and the Firths of Forth and Tay, whilst the largest totals are in Dartmoor, Exmoor, the English Lakes, north and central Wales, and north-west Scotland. The dates of rainfall excess vary considerably in different areas, and it is found that October is the wettest month on parts of the east coast, the Isle of Wight, and the Severn Estuary, but December gives the greatest rainfall in all other parts of Great Britain. The driest month is September in Hereford, Gloucester, Wiltshire, Oxford, Cambridge, Suffolk, Essex, Surrey, and North Kent, but June over the rest of the country. It does not, of course, follow that a district with a relatively high rainfall has a correspondingly large number of rain-days, as the two quantities do not vary in the same proportion, especially during some of the summer months when thunderstorms may cause a high rainfall total, yet be associated with a minimum number of rain-days. It is interesting to note that if a straight line be drawn from the south-east to the north-west of England, there is a steady increase of rain-days on that line northwards.

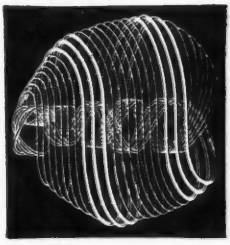
Floods and droughts can be equally destructive, although perhaps greater publicity is given to news of floods owing to the more spectacular damage that results from them. The question as to whether our water-supply arrangements are adequate to withstand long-period droughts, however, is still vital and debatable. A very famous meteorologist has asserted that, if such a long-period drought as during the years 1738–60 ever returned to this country, there is not a single town in the British Isles in which the water-supply arrangements for the needs of the present-day increased population would not completely break down.

Throughout those 22 years, there was only 1 year with a rainfall above the average, and the other 21 were all drought years. Admittedly, there has never been a recurrence of such an absence of rainfall in Britain, but, on the other hand, we must face the possibility that what has happened once might quite conceivably happen again.



MODELS OF ATOMS

by R. E. D. Clark



THERE is a widespread feeling in the minds of many people that it is only the mathematicians who can take an intelligent interest in the goings on of the atomic world.

Though widespread, this idea is completely fallacious. Physical models which can be understood by the ordinary man certainly have their limitations, yet they are used to-day in many branches of research. Their use is, in fact, increasing daily.

Before we discuss recent models let us consider some of the models of the past. The schoolmen of the Middle Ages did not believe in atoms but they believed in a universal medium or ether (*primum mobile*) out of which all things were made. This idea continued after atomism had become generally accepted and it was supposed that atoms were vortices in the ether and so could be changed into one another. But it was only rarely that the experimental philosophers of the seventeenth century committed themselves on such matters.

As for the shapes of atoms, two main views were entertained. According to one, atoms had hooks upon them and so occasionally joined together. According to the other (held by Robert Boyle) it was supposed that atoms were like balls with tiny spears sticking out of them with which, every now and again, they pierced their neighbours. When this happened the latter were unable to free themselves and so small clusters of atoms were formed, clusters which we to-day call by the name of *molecules*. Boyle thought that the spears of acids were especially long and sharp, and that when they pricked our tongues we experienced the all too familiar acid taste!

During the subsequent century, atoms were almost forgotten. To the world of that day the great developments in mathematics seemed to be inconsistent with atomism. The calculus enabled the flow of air or the movements of a ship through the ocean to be discussed just as if neither water nor air contained ultimate particles of matter. The idea that nature contained atoms therefore became superfluous, and further attempts to picture what they looked like came to a standstill.

At the beginning of the nineteenth century scientists found that they could not do without atoms after all. It was the chemists who reintroduced them first, but even they were sometimes a little ashamed of having done so. In later days, when organic compounds had to be represented by fairly elaborate arrangements of atoms, there were still some who thought that these atoms did not really exist at all. They were supposed to be mere concepts or ways of describing nature, but possessing no more reality than $\sqrt{-1}$.

In the second half of the nineteenth century atoms were often conceived as hard round objects rather like billiard balls. This simple conception was extraordinarily suc-

cessful: it explained the behaviour of gases with great accuracy, and it was confidently hoped that in time the entire range of natural phenomena would prove explicable in terms of models of this character. Indeed,

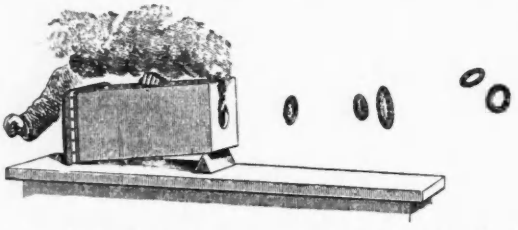


Fig. 1. Smoke rings were at one time considered to afford a close analogy to vortex rings in the ether, out of which atoms were supposed to be constructed

many scientists, Lord Kelvin in particular, said they could understand nothing in nature save with the aid of models.

It is probably safe to say that at this time scientists did not really *believe* that atoms were like billiard balls. There was merely no reason as yet to think of a more complicated model—though speculations on vortex atoms (like smoke rings) in the ether were soon on the scene. The doubtful honour of being the first to draw really complicated pictures of atoms seems to belong to William Babbitt (1876). His views were later adopted by the Theosophists, who to this day publish astonishing pictures of atoms as seen by clairvoyance!

With the discovery of radioactivity and radium in the early years of the present century, atomic models entered upon a new phase. Radioactive atoms were found to emit high-speed particles, and by firing these at other atoms it was possible to explore the insides of the latter. As a result Rutherford and Bohr produced atomic models like tiny solar systems. In the middle was a positive charge of inconceivable smallness, while around it electrons circulated in definite orbits. Sometimes the electrons jumped from one orbit to another —if they jumped into bigger orbits the atoms took, as it were, a mouthful of energy from outside, while if they jumped into smaller orbits light was emitted.

Before long, models of atoms entered a new phase. The fact that energy changes took place in discrete jumps, taken in conjunction with several other discoveries, eventually placed the model-making scientists at a discount. Even the electron ceased to be thought of as a particle and became a wave with no fixed position in space and time. Popular scientific writers began to pour scorn upon the naïvety of the billiard ball-minded nineteenth century. Once again it was said that mathematics gave a truer understanding of nature than all the models of the past.

In a sense this is still the position to-day—though, as we have already remarked, there are signs that models are coming into their own once more. At present it is generally agreed that no single model can give us an adequate picture of the behaviour of an atom. Yet without models science would not have got far. True, those who have developed the wave theory of matter no longer think in terms of atoms like solar systems, yet to our surprise we find that all the possible modes of vibration of a drop of liquid are faithfully reproduced in the atom!

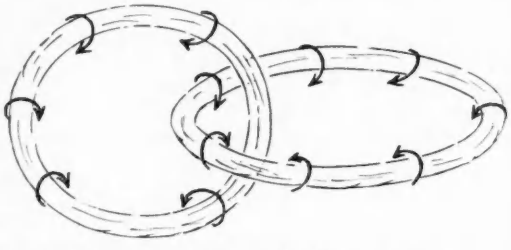


Fig. 2. The sodium atom made from two vortex rings (Kelvin 1867)

When we turn to consider not individual atoms, but small groups of such atoms which

have become joined together (molecules), we find that atomic models are being used more to-day than at any time in the past.

At the present time scale models of countless molecules are being made every day in chemical laboratories, and by their use it has been found possible to predict many new phenomena. One of the most interesting of these concerns the "knocking" of one part of a molecule against another. If a molecule is shaped as shown in Fig. 13 the large round atom *A* will be unable to pass either of the blocking groups or atoms *BB*, but will continually collide first with one of them and then with the other. In this case it is found that scale models indicate accurately whether or no given groups will be able to pass one another. The effect of the "knocking" can be observed by the action which such molecules have upon (polarized) light.

Models have also been of great use in the study of surface chemistry. When a gas comes in contact with a solid, it deposits a very thin layer of molecules on the surface which often stick with great tenacity. Many chemical reactions take place in these layers which are frequently only one molecule thick. Models of the surfaces looking like chessboards, with atoms on only some of the squares, have thrown much valuable light upon the mechanisms of chemical changes.

Models have also proved of the greatest importance in the study of crystals. Balls (of the nineteenth-century variety!) can be

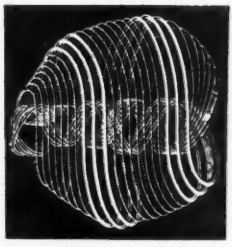


Fig. 3. The atom as William Babbitt conceived it

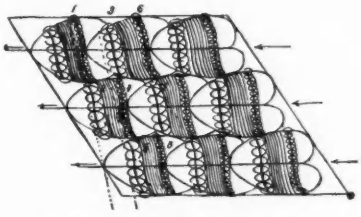


Fig. 5. A group of Babbitt atoms joined together

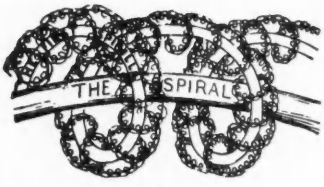


Fig. 4. A part of the same more highly magnified

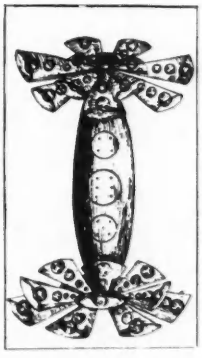


Fig. 6. A single atom of the element sodium as seen by clairvoyance!

packed together in different ways, depending chiefly upon their relative sizes. X-ray analysis has shown that these possible arrangements are accurately reproduced in the realm of the atoms, showing once again the enormous value of simple physical pictures.

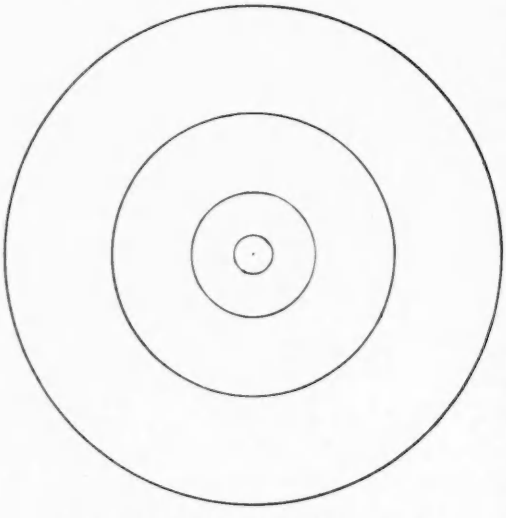


Fig. 7. Orbits of the Rutherford-Bohr atom

Recently, simple atomic models have been put to a new use—one fraught with great possibilities for the future.

It has long been possible for scientists to calculate how frequently molecules of one kind hit molecules of another kind in a mixture of gases. If the reaction takes place in solution—say in water—it is still possible to calculate how frequently molecules collide *on an average*, but for many purposes this information is not now sufficient.

New light has recently been thrown upon this important point by the use of models. Figs. 11 and 12 show a star-shaped tray containing balls which can be agitated violently (high "temperature"). The black centre ball is fixed, and things are so arranged that when the two black balls hit one another an electrical circuit is completed, while other collisions produce no effect. In this way it is possible to study a chemical "reaction" (collisions of the two black balls) taking place in a "solvent" (white balls).

The results are surprising and have thrown much light on real chemical reactions. It is found that if there are no "solvent" molecules present a molecule will hit first one of its neighbours and then another in rapid succession. But if there is much solvent, it hits one of its neighbours many times in succession before the two are separated. After that there is a comparatively long delay before another molecule is encountered—when the same process is repeated again.

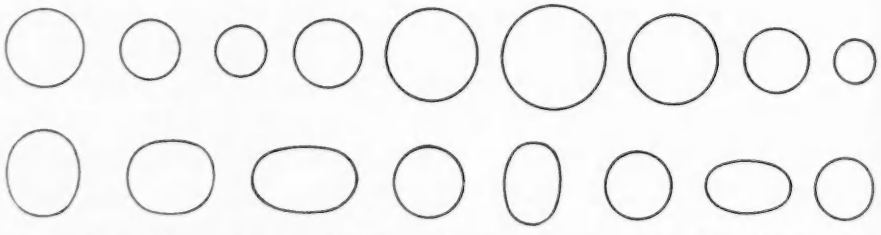


Fig. 8. Each of the possible types of oscillation found in a drop of water is reproduced in the atom. This figure shows two types; a uniform swelling and shrinking, and, below, tidal oscillation

Not long ago experiments were tried at

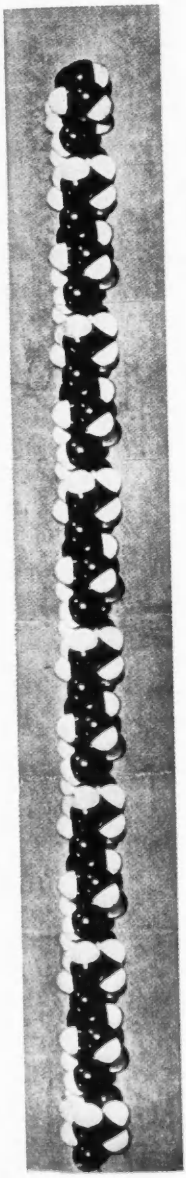


Fig. 9. *Model of a single-molecule (making a fibril) of cellulose.*

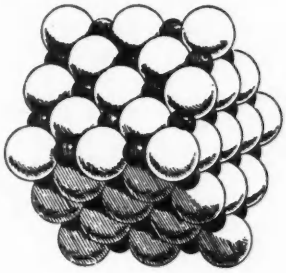
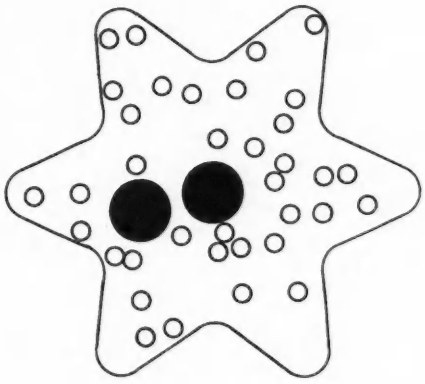
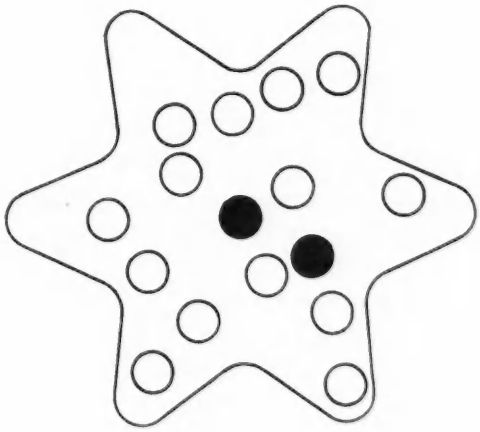


Fig. 10. *Model of the arrangement of the atoms in a crystal (sodium chloride)*



Figs. 11 & 12. *Machines used to investigate model chemical reactions*



Oxford to see whether the size of the "solvent" molecules altered the results. It was found that if the "solvent" molecules were very small, they tended to become

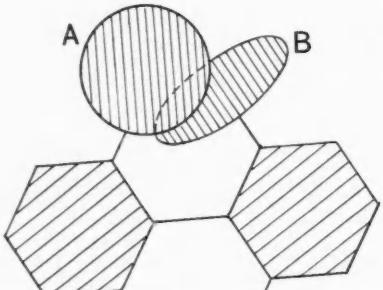


Fig. 13. *In some molecules the atoms "knock" into but cannot pass one another. Thus, in the figure,* **A** *is fixed to the front of atoms* **BB** *and cannot get behind them*

packed together in groups. As a result the larger balls hit each other much more frequently than before, especially if the small balls were numerous. This result was put to the test in real chemical reactions, and results were obtained exactly similar to those expected on the basis of the model.

The making of good models for the study of chemical reactions is difficult from a mechanical point of view, and such models are still in their infancy. Yet they may well have a vast future before them. To-day, not only the size but precise measures of the forces which hold atoms together are becoming known with ever greater certainty. The time cannot be far distant when it will be possible to make a scale model of an organic molecule, in which the forces required to detach each separate portion of it will correspond exactly with the actual forces required in a real molecule.

If ever this could be done relatively cheaply, it might be possible to place large numbers of such models in a box and submit them to a regulated amount of shaking ("temperature") and then mix them with models of other kinds. As a result of an experiment of this kind much valuable information might be gained. Indeed, if we let our imagination run freely into the future, we can almost see chemists building elaborate models of virus proteins and even, perhaps, bacteria, and submitting them to the action of other curiously shaped models in large shaking machines! Then at last chemistry will have passed the empirical stage and chemists will be able to see just how their molecules react.

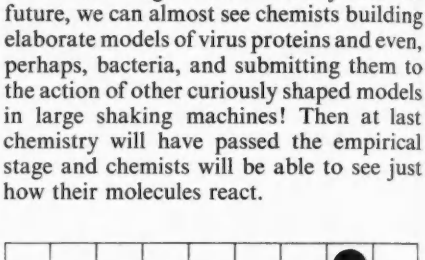


Fig. 14. *Models of surfaces looking like chess boards, on which some squares are covered with molecules and some are vacant, have been much used in the study of chemical reactions*

From these new developments, one thing at least stands out clearly. The layman of to-day has less cause than ever before to fear the future march of science. Mathematicians *may* and indeed *will* do their worst, but a great deal of what goes on among the atoms will certainly be intelligible to Mr Everyman!

Reviews of New Books

Country Relics

Most country towns include a few "bygones" among their collections, but it seems mainly to have been left to individuals to assemble more than hap-hazard collections. It is true that at Colchester, for instance, private enthusiasm has been responsible for assembling in the museum a representative collection of East Anglian pre-mechanical tools and implements, whilst the folk crafts and industries collection in the National Museum of Wales is deservedly well known; but is it not a positive duty of the authorities to assemble, before it is too late, representative collections from every locality in the country?

Among private collections, Mr Massingham's, though still in its infancy, promises to rank among the most important. Housed in a "Hermitage", which he had built in his orchard, it already contains between one and two hundred tools and implements and properties of craftsmen and husbandmen, ranging from a long plough (probably the only one now surviving in England), breast plough, latten bells, seedlips and costrels to such relatively familiar domestic trifles as bread-peels, chimney cranes, pattens, smocks and goffering irons.

Country Relics,* then, is the detailed and highly informative record of these tools and properties, a strict and authoritative account of their usages, together with sensitive and unsentimental portraits, drawn from life, of the kind of craftsmen and craftswomen who used them. Coupled with Mr Massingham's expert text are drawings by the author-illustrator of *Change in the Farm*; and is there anybody living who knows better how to capture in line the texture and shape and poignancy of these survivals from an age when (to quote Mr Massingham's own words) "for the craftsman work, play and religion were three orders of arches that framed the window of life"? It is, too, in the very spirit of these old craftsmen, to whom the modern ideal of shorter hours would have been unthinkable and whose chief pleasure was to produce "a work a-blest", that the book itself has been produced.

"What I cared about", says Mr Massingham, "even more than the preservation of these tools in the Hermitage was that each should retain its own aura of associations." As he turns them over, in the pages of this book, appreciating their beauty-in-utility and recreating in his mind the civilization of which they are the everyday expression, little wonder if indignation fills him for the passing of these things and for the kind of gim-crack workmanship that has been allowed to take their place. Like his own Mr Dadge, the dry-waller of Windrush, he is "a bitter critic of the masterman's present lot, the desertion of the countryside, the relapse of the ploughing lands, the depreciation of quality in output, the prostitution of village life, and the economic insecurity of his (the craftsman's) kind". These men gave the community they served exactly what is needed and in good taste, and their diminished status is one of the strongest indictments of this age of catch-penny substitutes.

Objections to the machine (it is a pity Mr Massingham does not define where the machine begins its baleful influence: perhaps it was with the arrival of the internal combustion engine, a disintegrating explosion?) are easy game for the scientist; but where is the answer to that sage farmer's objection that tractors "take the song out of the job"? Until the song is put back again, the machine's gift of shorter hours and bigger profits will avail us nothing. It is Mr Massingham's hope that somehow, somewhere, this may yet be achieved. For the present large-scale farming for profit he would substitute "small holdings or small ownerships in small communities"; and then, "if Englishmen ever again have a stake in their own land—and that seems a good thing even if it is an old thing—a collection of 'bygones' (such as his own) may be of service to posterity in supplying ideas and models for future tools".

C. HENRY WARREN

* *Country Relics*, by H. J. Massingham. Drawings by Thomas Hennell. Camb. Univ. Press, 15*s*.

Minaret and Pipe Line

Ordinary newspaper readers wishing to form an intelligent opinion about Near Eastern problems have been at a loss to know where to turn to for impartial enlightenment. Here* in bold outline is sketched-in the background of the past and the foreground of the present: the history and migrations of the heterogeneous races, the warring creeds, the sectarian hates (both Muslim and Christian), the conquests, oppressions, massacres, the languages, the hopes and dreams of the conglomerate of peoples that inhabit the countries known to-day

* *Minaret and Pipe Line; To-day and Yesterday in the Near East*, by Margret Boveri, translated by Louisa Marie Sieveking. Oxford, 21*s*.

as Iran, Iraq, Arabia, Turkey, Syria, Palestine and Trans-Jordan. Here too are analysed the problems arising from climatic conditions, from nomadic migrations, from the clash of twentieth-century mechanics with patriarchal tradition, from the rise of "Oil Sovereignties" that cut across political, religious and ethnographic boundaries and awaken primeval greed of gain.

In a book covering so wide a geographical field and so long a stretch of human history, a writer even of Dr Boveri's learning and first-hand knowledge is bound to fall into occasional error, such as the odd mis-statements that the British Residency has been removed from Bushire (which it has not) or that the Rub' al Khali was first crossed by Sir Thomas Bertram, a title under which Dr Bertram Thomas will hardly recognize himself. Experts in the various fields may be left to correct such details, the general reader need not be deterred by them from feeling lively gratitude for a helpful, timely and illuminating study. The translator has brilliantly succeeded in providing a version so lucid and so idiomatic that it might be an unusually well-written English book. The text would have been even more pleasing if under scholarly advice the accepted English forms, Haji, Wazir, Sunni, Wahhabi and the like had been substituted for the foreign Hadji, Vizir Sunnite, Wahhabite, etc., and surely Oxford could have produced a vastly better general map. The small sketch-maps and the generous Index are, on the other hand, items to be grateful for.

E. O. LORIMER

Hormones in Invertebrates

This book* does not attempt to provide a popular exposition of the subject, and I do not think that anyone but a trained biologist would make much headway with it. For the professional biologist, however, it will be very useful, since it contains a complete account of everything that has ever been written on the subject of hormones in invertebrates, well arranged, well illustrated, and with a good bibliography.

Of the more straightforward aspects of the subject, such as colour change mechanisms in the Crustacea, or the hormones responsible for controlling moulting in insects, there is a critical and well informed account which will be of interest to all biologists, but on more general topics, such as the action of invertebrate hormones on vertebrates, the book is rather disappointing. In his anxiety to include an account of all the experimental work and yet not to make the book too long, the author has severely cut down the discussion of the general aspects of the problem, with the result that although the book provides a sound basis for thought, it cannot be said to be "thought-provoking". Granted that invertebrate hormones do act on vertebrates, and *vice versa*, one is chiefly interested in trying to find out what are the fundamental principles controlling their action which are common to the two groups. The mere multiplication of instances to show that some invertebrates do contain substances which have a pharmacological action on vertebrates loses interest if it is not accompanied by a full discussion. Some of the experiments described seem to have been rather long shots: the gentleman who injected an extract of silkworms into pregnant guinea pigs for example seems to be a fair target for the old gibe "Have you tried limejuice?"

M. P.

* *Hormones in Invertebrates*, by Bertil Hanström. Oxford Univ. Press, 12*s.* 6*d.*

Select List of Books Received by *Discovery*

(*Mention in this list does not preclude review*)

College Course of Inorganic Chemistry. J. R. PARTINGTON. (Macmillan, 8*s.* 6*d.*)

Inorganic and Theoretical Chemistry. (5th edition.) F. SHERWOOD TAYLOR. (Heinemann, 12*s.* 6*d.*)

The Fundamentals of Biochemistry in Relation to Human Physiology. T. R. PARSONS. (6th edition.) (Heffer, 10*s.* 6*d.*)

Matter, Motion and Electricity. SMYTH and UFFORD. (McGraw Hill, 25*s.*)

The Psychology of Conversation. T. H. PEAR. (Nelson, 2*s.* 6*d.*)

Twenty Years of Psychical Research. HARRY PRICE. (Longmans, 10*s.* 6*d.*)

Nature Parade. FRANK W. LANE. (Jarrolds, 15*s.*)

Wild Foods of Britain. JASON HILL. (A. and C. Black, 2*s.* 6*d.*)

The Nile Basin. H. E. HURST. Second Supplement to Vol. 2. (Schindler's Press, Cairo, 10*s.*)

Two Men in the Antarctic. THOMAS WYATT BAGSHAWE. (Camb. Univ. Press, 15*s.*)

Oxford Pamphlets on World Affairs, 17, 18, 19, 20.

The Advancement of Science. The Report of the British Association for the Advancement of Science.

The Bulletin of the Imperial Institute. Vol. XXXVII, No. 3.

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